Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

TECHNOLOGY DEPT
1010 EMPIRE BUILDING

February, 1945

PITTSBURGH, PA.

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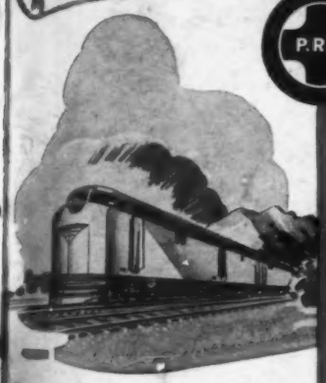
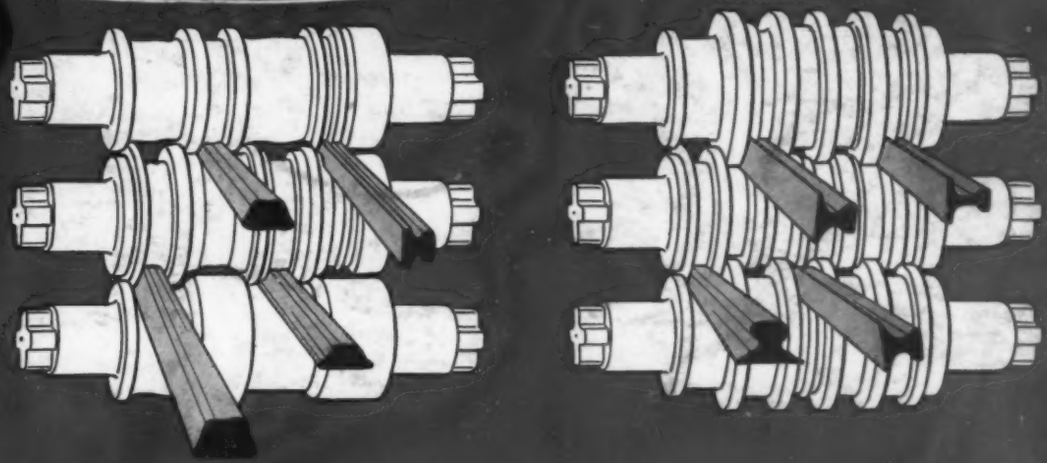
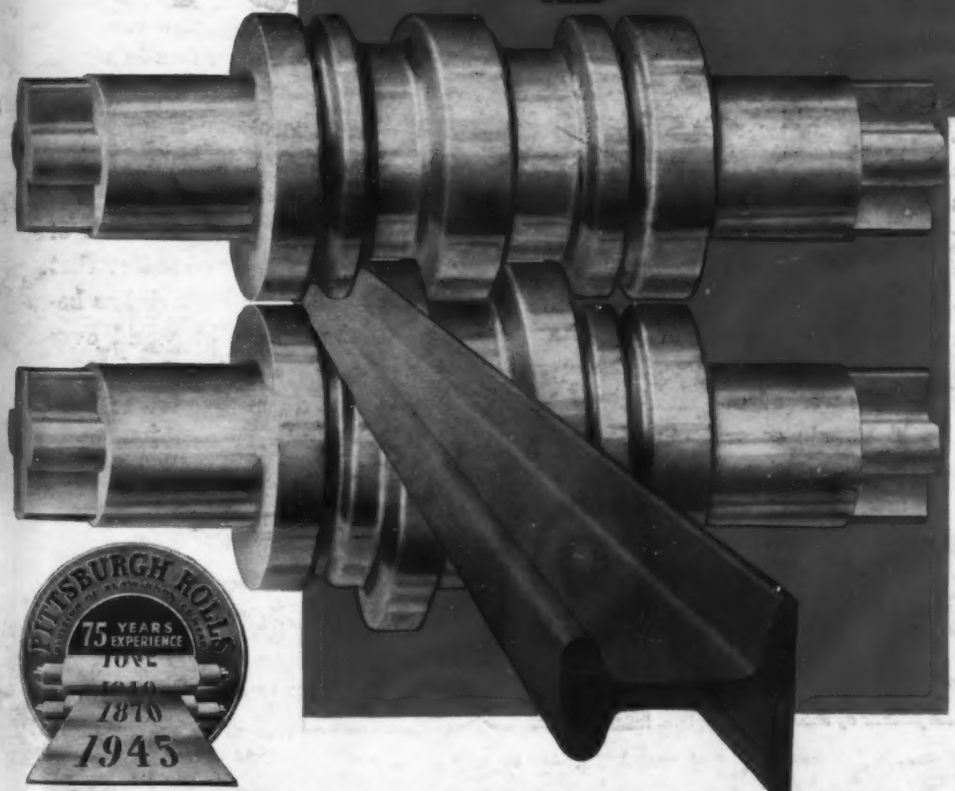
P.R.W

ROLLING TECHNIQUE ... RAILS

P.R.W







You just take a red-hot billet of steel and pass it 8 or 10 times through a Pittsburgh roll and out comes a rail ready for duty on the road. Sounds simple, doesn't it? Perhaps it is, but behind that simplicity there are several generations of know-how provided by roll-makers and the men who use them.

Today America's vast systems of railroads operate an "assembly line" 399,000 miles long—much of which needs replacement NOW . . . Pittsburgh Rolls will help get your share of this business at *less cost per ton of steel rolled.*

PITTSBURGH ROLLS
Division of Blaw-Knox Co.
PITTSBURGH, PA.

PITTSBURGH ROLLS
75 YEARS EXPERIENCE
1870
1945

PITTSBURGH ROLLS P.R.W

ELECTRONICS IN OVERALLS

This infant prodigy has been growing up for 28 busy years

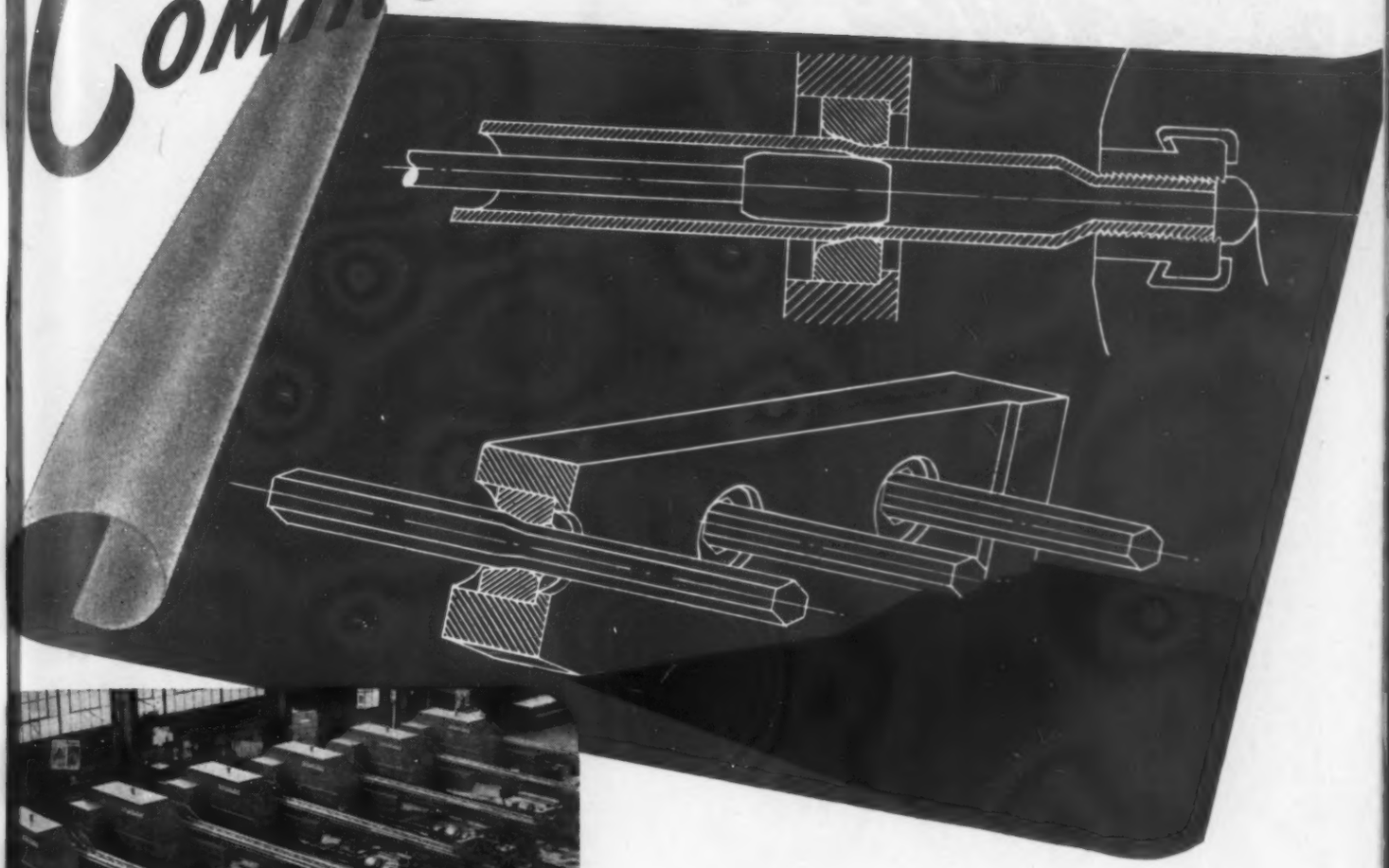
In recent years nearly everyone has come to know about electronics, the *new* tool of engineers that performs near-miracles with strange-looking big brothers of your familiar radio receiving tubes. The many important wartime uses of electronic tubes have lately given them front page prominence. But what many people do not know is that today's electronics is *not* a "war-baby" or a recent discovery, but the child of much pioneering and many years of steady development. Over a quarter-century ago, even before U. S. entry into World War I, and long before most people saw their first radio tube, Cutler-Hammer engineers put electronics "into overalls" and showed how tubes could solve many of Industry's machine, production, and electrical control problems. As early as 1916, Cutler-Hammer engineers worked out some of the basic electronic control circuits and the original designs for some of today's most widely used industrial tubes. Such pioneering has played its vital part through the 28 years in which the infant prodigy, industrial electronics, has been growing up to its present position of even greater promise. And this pioneering continues . . . to enhance the value of every piece of motor control that bears the trademark which has become synonymous the world over with progressive engineering and utmost dependability. CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

Engineering excellence finds its greatest reward in the respect and confidence of those it serves

CUTLER-HAMMER
MOTOR CONTROL
C-H

NEW IDEAS IN DRAWBENCHES

COMING UP AT AETNA-STANDARD



AETNA-STANDARD MAKES COMPLETE SIZE RANGE OF DRAWBENCHES

From Aetna, you can buy a bench for any capacity between 1000 and 300,000 pounds, for either tubes or bars, ferrous or non-ferrous, multiple or single drawing, ⅛" to 16" O. D.

Prompt attention to your drawbench inquiry

SEVERAL new developments for post-war drawbenches have been evolving in Aetna-Standard's engineering department. Consider a few of Aetna's more recent improvements — high speed carriage returns, automatic discharge arms, and improved type loading racks. The full mechanical drawbench with double mandrel rod ends has increased production, in some cases as much as 100%.

Many developments and innovations in the cold drawing industry over the years have been pioneered by Aetna-Standard.

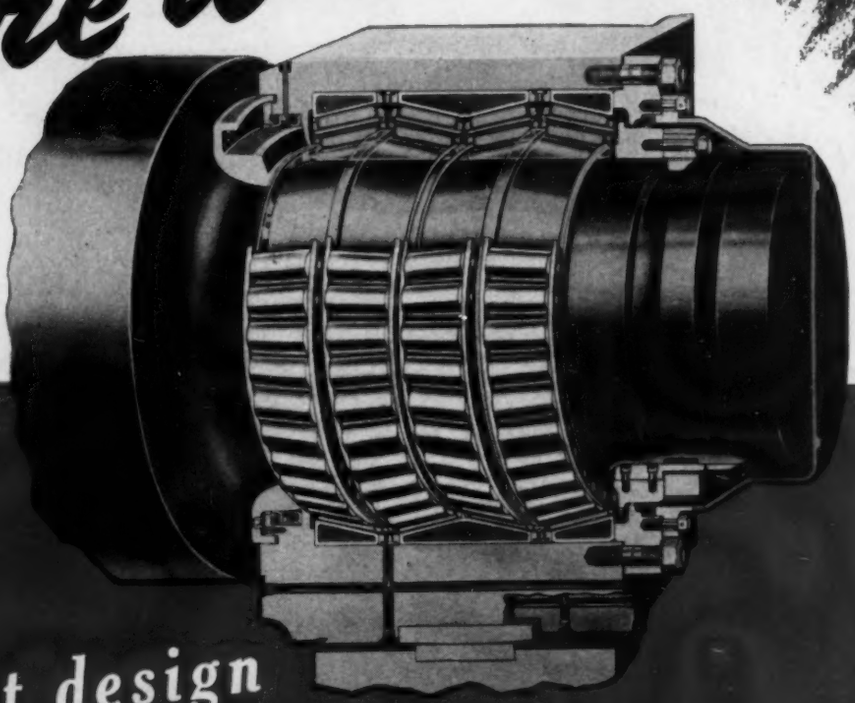
THE AETNA-STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries.

ASSOCIATED COMPANIES:
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

Here it is!



the latest design of the Famous Timken Four-Row Roll Neck Bearing!

A New Year — a New Timken Roll Neck Bearing! New opportunities for increased strip and plate production at reduced cost!

All of the original, time-tested features pioneered by us have been retained in this 1945 version of the Timken Roll Neck Bearing. New features have been added to give the bearing still greater endurance; longer life; increased precision; and easier handling on and off the roll necks.

Use this new development of The Timken Roller Bearing Company that will give new mills the extra speed, dependability and economy they will need so urgently in the years following victory. Write for further information with specific reference to your particular requirements. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN

TRADE MARK REG. U. S. PAT. OFF.

ROLL NECK BEARINGS

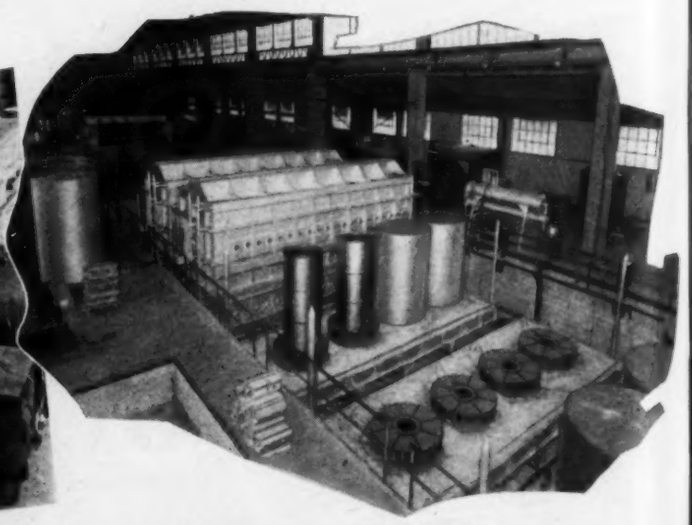
HYDROPRESS · INC.
ENGINEERS CONTRACTORS
HYDRAULIC PRESSES · ROLLING MILLS
STRETCHERS · PUMPS · ACCUMULATORS
570 LEXINGTON AVENUE · NEW YORK · N. Y.

WILSON BELL TYPE FURNACES for COILED STRIP ANNEALING

TIN PLATE
SHEET COILS
STRIP COILS

CYLINDRICAL AND RECTANGULAR TYPES WITH VERTICAL RADIANT TUBES

The standard Lee Wilson bell type furnace with vertical radiant tube heat application still offers the most uniform temperature distribution, the most uniform annealing with lowest production and maintenance costs.



The Wilson Annealing Unit is covered by Patents Nos. 1,952,402, 2,068,477, 2,078,356, 2,081,612, 2,089,843, and other patents pending.

ENGINEERED AND CONSTRUCTED BY THE

Lee Wilson ENGINEERING Co., Inc.

20005 West Lake Road CLEVELAND, OHIO
Telephone ACademy 4670

Sold by The WEAN ENGINEERING CO., Inc., Warren, Ohio

INDUSTRIAL FURNACES ★ RADIANT TUBE HEATING ★ HEAT TREATING PROCESSES

A BIG Brake for Large Motors

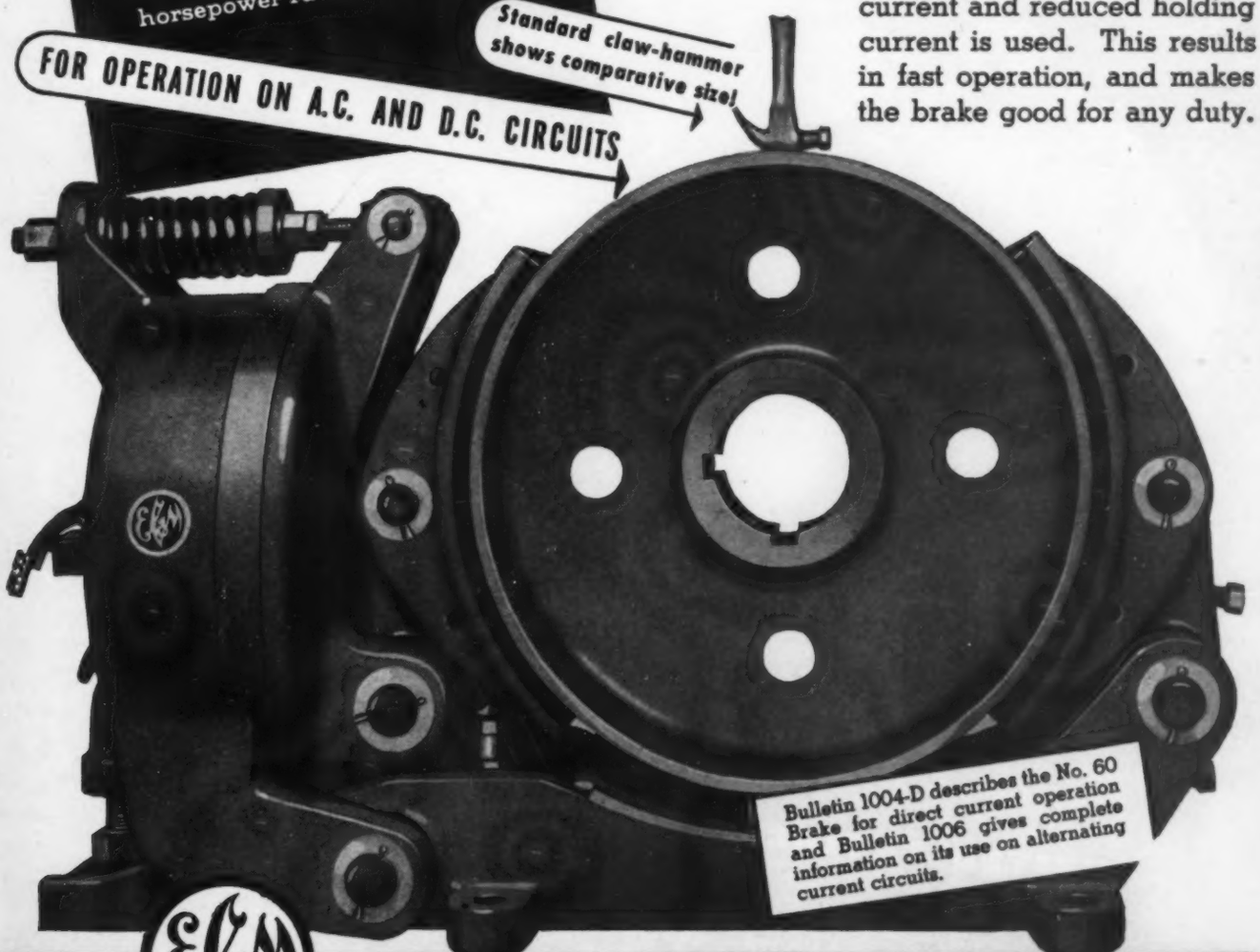
THE NEW EC&M NO. 60 WB BRAKE Rated At 7200 lbs./ft.

For ore unloaders . . . blast furnace skip hoists . . . mine hoists . . . and similar installations using motors of large horsepower rating.

FOR OPERATION ON A.C. AND D.C. CIRCUITS

This No. 60 Type WB Brake is designed for large motor applications where high torque is required to stop and hold the load. Its construction includes features such as—(1) a welded steel frame, (2) super-oilite, self-lubricating bearings, (3) case-hardened steel bearing pins, (4) moulded brake blocks, 3/4" thick, which wear down slowly.

The direct current No. 60 Brake is furnished as standard with shunt-wound operating coil and protective resistor. For high speed operation giving fast release and quick set, an automatic relay to allow high releasing current and reduced holding current is used. This results in fast operation, and makes the brake good for any duty.



Bulletin 1004-D describes the No. 60 Brake for direct current operation and Bulletin 1006 gives complete information on its use on alternating current circuits.

THE ELECTRIC CONTROLLER & MFG CO.

2698 E. 79th ST. ★ CLEVELAND 4, OHIO

UNITED ROLLS

. . . everywhere!

REG. T. M.

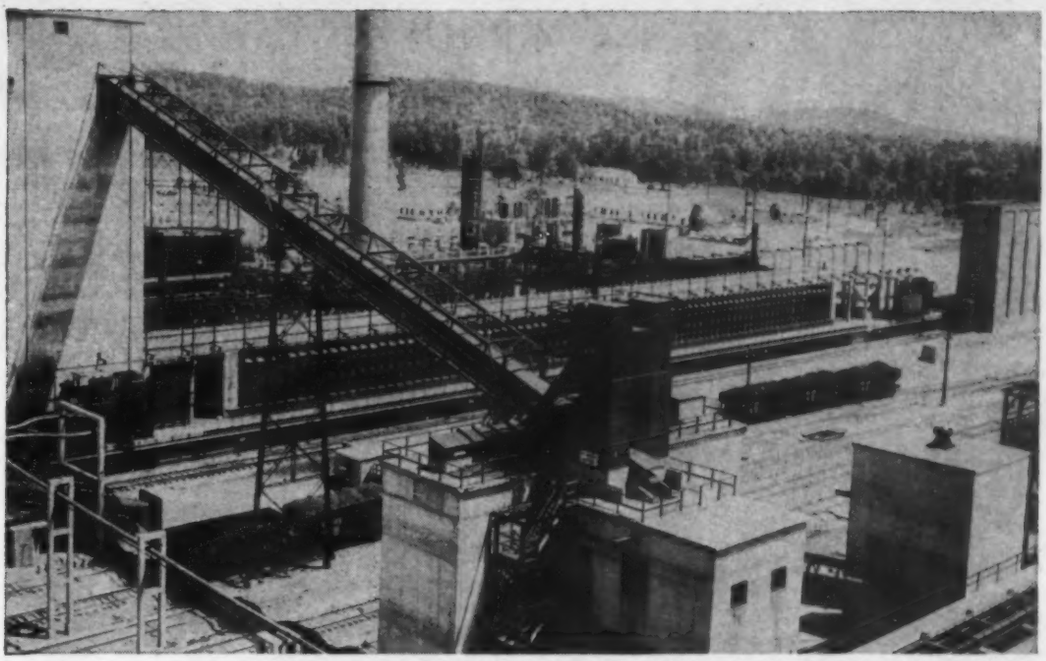
UNITED ROLLS of all types, grades and designs for the hot or cold processing of ferrous or non-ferrous metals, rubber, synthetic resins and other materials, are rolling in constantly increasing volume to every important industrial center at home and abroad. Their universal acceptance over a period of more than 40 years, by the industry's principal users, is proof of their high quality and superior performance.

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at Pittsburgh, Vandergrift, New Castle, Youngstown, Canton
Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q. Canada

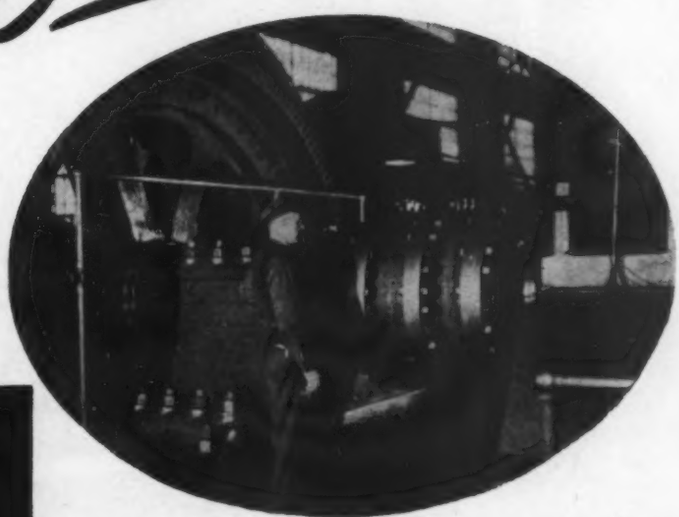
** The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment*



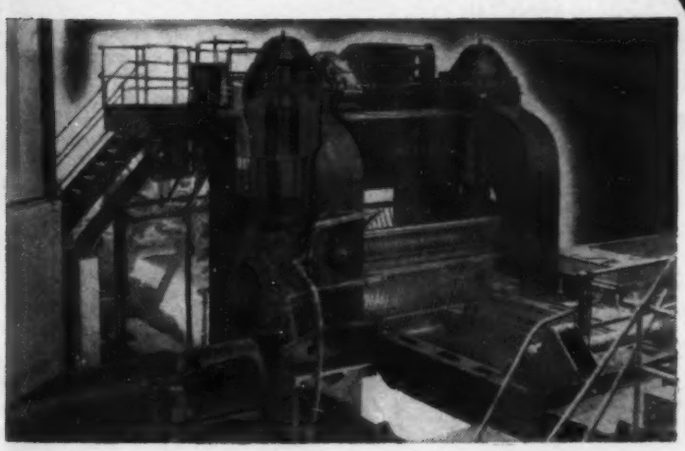
NEW COKE PRODUCTION FACILITIES AGGREGATE 12,500,000 TONS ANNUALLY—In four years of national emergency, America has built additional *new* steel production facilities nearly the size of England's prewar steel industry. Blast furnace output in America jumped from 56,500,000 tons in 1941 to over 67,000,000 tons now. That meant an added demand for almost 11,000,000 more tons of coke. This has largely been met by the building of new Koppers-Becker coke ovens since September, 1939, which annually produce approximately 12,500,000 tons of coke and billions of feet of gas.

KOPPERS

and the *Steel Industry*



UNEXCELLED WEAR RESISTANCE IN STEEL MILL PARTS—For the many parts of rolling mills and other equipment which must withstand terrific impacts in the rolling and shaping of steel, the steel industry uses a bronze alloy developed by Koppers Bartlett-Hayward Division. This D-H-S Bronze possesses the highest combination of three very desirable qualities . . . Ductility, plus Hardness, plus highest Strength.



YEARS OF UNFAILING SERVICE THROUGH FAST'S COUPLINGS—Because a single coupling failure can shut down an entire rolling mill and other departments, dependability is of utmost importance. This picture shows the first large heavy-duty Fast's Coupling ever built, and today it is delivering 3000 HP at 135 RPM—more than 20 years after it was installed.

KOPPERS COMPANY, INC.

Koppers Building, Pittsburgh 19, Pa.

MESTA BAR MILLS

At the Chicago District's new electric steel plant . . . a Mesta 36" Roughing Mill for supplying billets to the 32" Bar Mill. The Leader, Intermediate and Finishing Stand of this mill are shown below.

The Army-Navy "E" flag with four stars, flies over the Mesta Plant

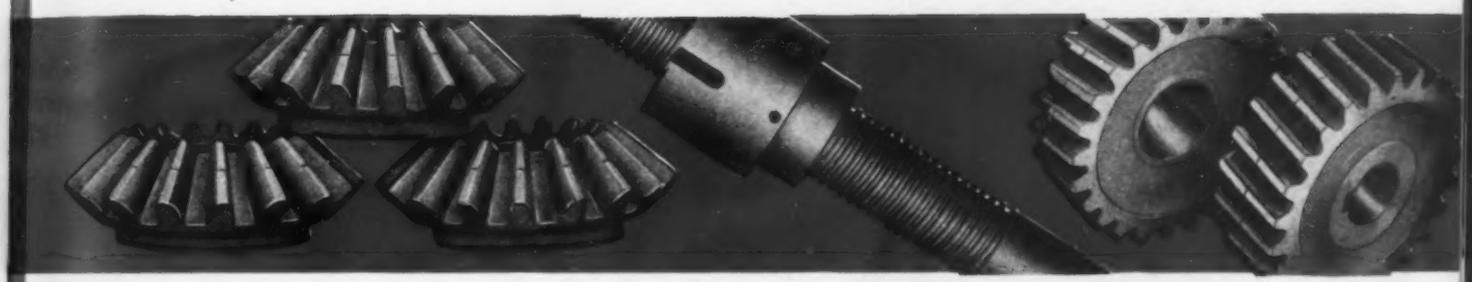
ROLLS AND STEEL MILL EQUIPMENT
HEAVY DUTY MACHINE TOOLS
FORGINGS

BUY EXTRA WAR BONDS

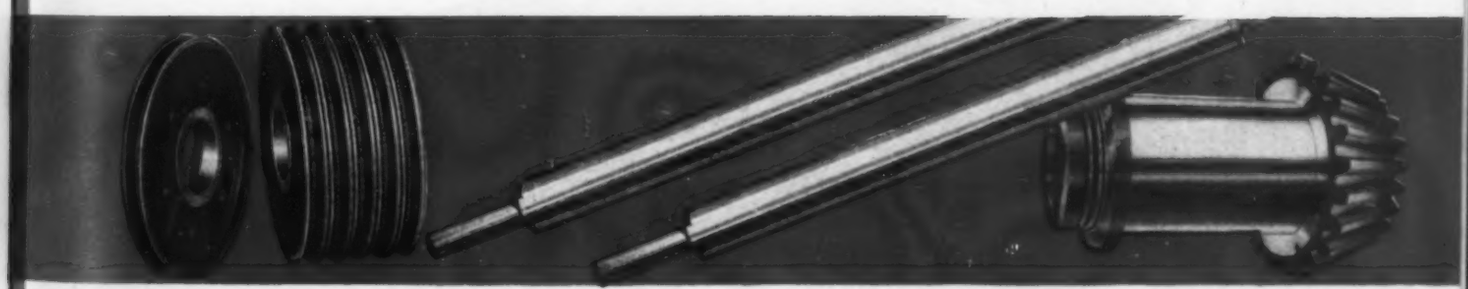
MESTA MACHINE COMPANY · PITTSBURGH, PA.

YOU'LL GET *Plus* PRODUCTION

WITH "TOOL STEEL" PROCESS



GEARS · PINIONS · ROLLS · WHEELS AND HARDENED PRODUCTS

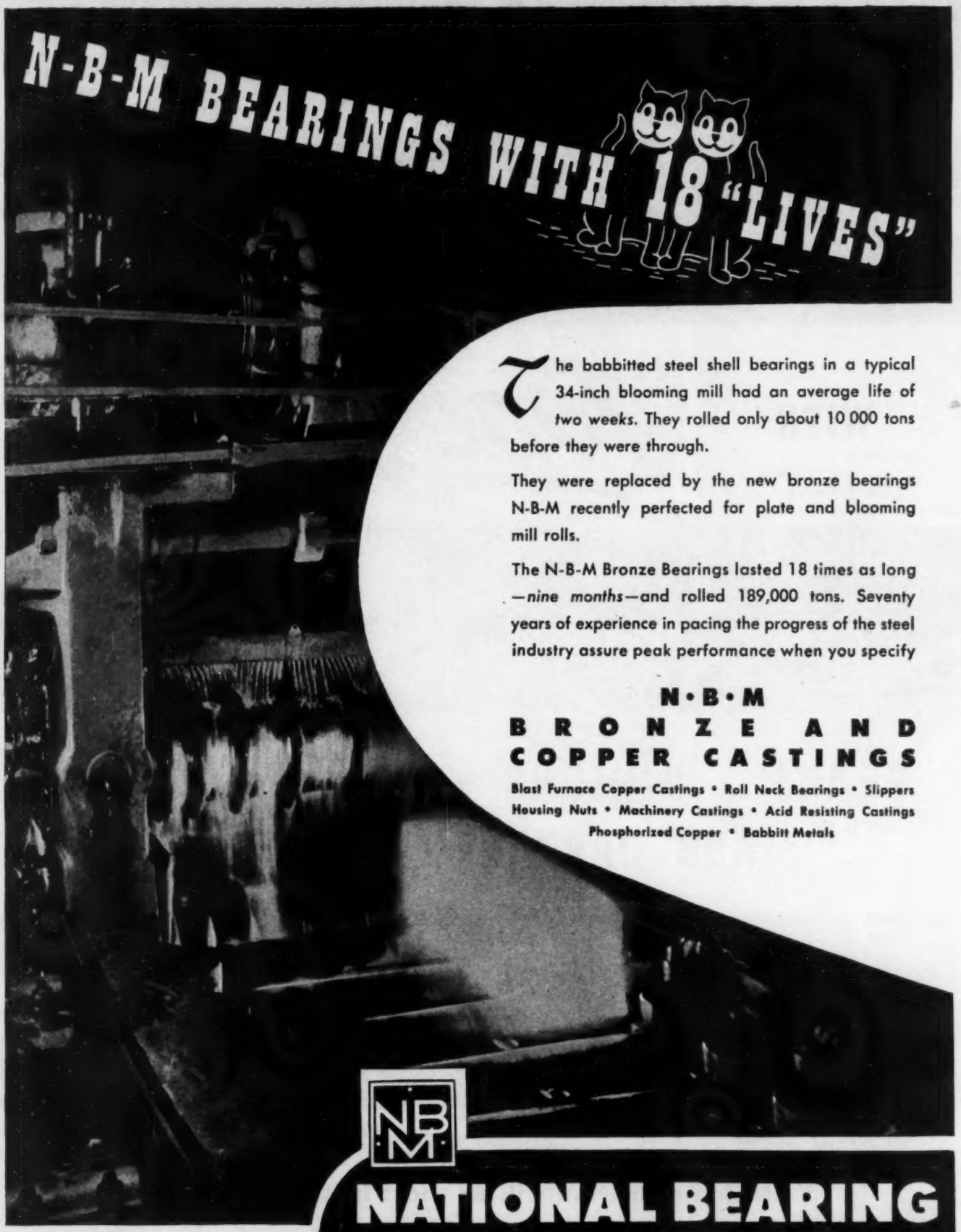


Plus **Production will be most important in the post-war competitive era. Better find out *Now* what "TOOL STEEL" PROCESS *Hardened Products* can do for you. Write for Bulletins.**

THE TOOL STEEL GEAR & PINION COMPANY

CINCINNATI 16, OHIO

N-B-M BEARINGS WITH 18 "LIVES"



The babbitted steel shell bearings in a typical 34-inch blooming mill had an average life of *two weeks*. They rolled only about 10 000 tons before they were through.

They were replaced by the new bronze bearings N-B-M recently perfected for plate and blooming mill rolls.

The N-B-M Bronze Bearings lasted 18 times as long —*nine months*—and rolled 189,000 tons. Seventy years of experience in pacing the progress of the steel industry assure peak performance when you specify

N·B·M
BRONZE AND COPPER CASTINGS

Blast Furnace Copper Castings • Roll Neck Bearings • Slippers
Housing Nuts • Machinery Castings • Acid Resisting Castings
Phosphorized Copper • Babbitt Metals

NBM

NATIONAL BEARING METALS CORPORATION

ST. LOUIS • NEW YORK

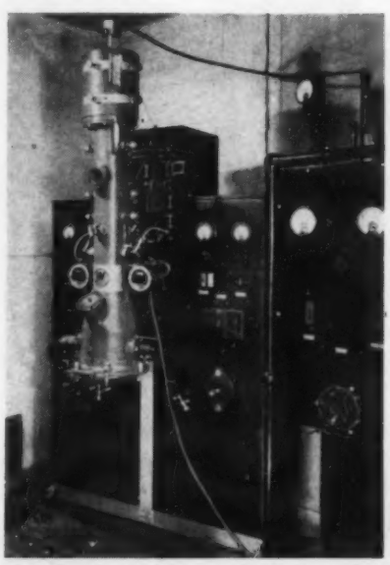
AMERICAN Brake Shoe COMPANY

PLANTS IN: ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

Testing a PENNSYLVANIA, 3 Winding, 138 Kv Power Transformer with an applied impulse test voltage of 750 Kv

Impulse Tested...

... to assure Reliable Performance!



Cathode-Ray Oscillograph with 60 Kv rectifier

Pennsylvania TRANSFORMER COMPANY has the engineering ability, research facilities and special plant equipment for building and testing all sizes and types of high voltage power transformers.

The impulse generator shown in the illustration is used for making impulse tests up to two million volts. It is equipped with a 150 Kv charging unit and a Cathode-Ray Oscillograph. This impulse testing equipment is used for both research and commercial tests.

Every Pennsylvania Transformer is designed to successfully meet impulse tests as well as other exacting requirements. This is but one of many reasons why Pennsylvania Transformers are known throughout the industry for their **reliability, longer life** and **lower maintenance.**

Pennsylvania TRANSFORMER COMPANY

808 RIDGE AVENUE, N. S., PITTSBURGH 12, PA.

A typical product of Erie Forge Company is this crankshaft for a Diesel engine. Its annealing and other heat-treat temperatures were Micromax-controlled as described below.

TEMPERATURE "CROWDS" AN A-C POINT WITH HELP OF MICROMAX PYROMETERS

Many of the huge forgings produced by Erie Forge Company require stress-relief anneal (or draw) at temperatures just below the AC_1 point of the steel. But — they must not enter the critical area; because any heating at or above the AC_1 point would involve additional expense for reheat treatment. Erie Forge Company, heat-treating in furnaces up to 70 feet long, holds temperatures at only 10 degrees below the AC_1 point.

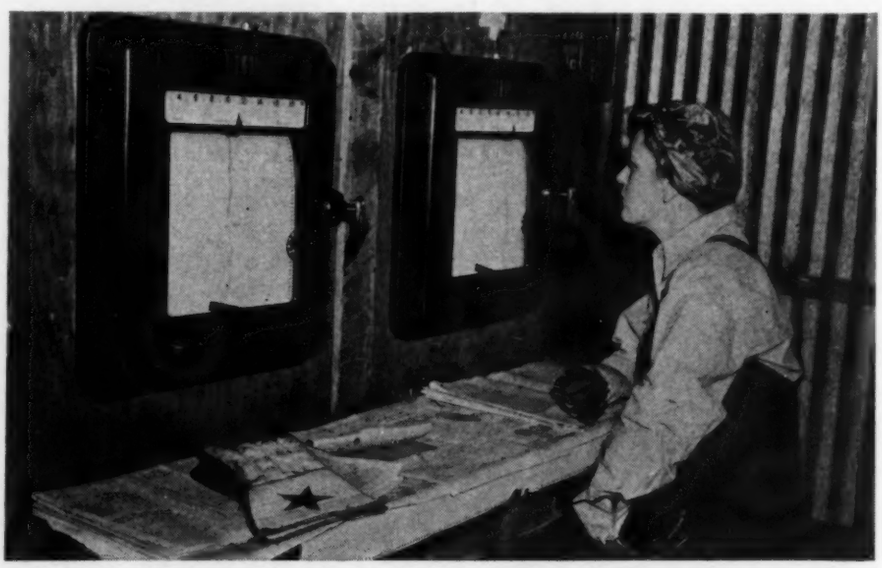
This slight margin, minus a safety factor, means that the pyrometers used to control the temperature must remain accurate to within plus or minus two degrees. And experienced men agree that an accuracy of two degrees in 1300, maintained by routine operators, for two weeks at a time, requires not only careful pyrometer installation and maintenance, but pyrometers of utmost inherent stability and dependability.

To carry this responsibility, Erie Forge has about 150 Micromax Pyrometers like the one shown above. Each is connected to twelve thermocouples; and each couple must be within a hair of absolute accuracy before it can be installed. When installed, thermocouples are placed in holes drilled to center of blocks, comparable in size to forgings being treated; the Micromax thus reports actual work temperature.

To be sure that these reports are accurate, an instrument mechanic visits each Micromax during each shift, and checks each couple with an L&N Portable Potentiometer. As soon as a couple begins to lose accuracy — in goes a new one.

An occasional check of the Micromax itself always finds the instrument absolutely "on the ball," so that if the couple is right, the record is accurate. In the final analysis, it's the dependability of Micromax performance which explains why Erie Forge and thousands of other firms are using these Recorders and Controllers on important temperature problems.

You may have such a problem; if so, an L&N engineer will either call, or send a catalog, as you prefer.



Furnace operator consults Micromax Recorder in regulating annealing temperature of a furnace in Erie Forge Company plant.

Jrl Ad N-33A-626(4)

depends on me!
A Slogan For Every American

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.
LEEDS & NORTHRUP
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

STANDS UP UNDER *SHOCK!*

Those spectacular paratroopers' boots are built to soak up a lot of shock when he hits the ground at 18 MPH . . . Likewise, "UNIVAN" castings, with their fine-grained Nickel-Vanadium steel structure, stand up under continuous shock with notable lack of fatigue . . . . . .

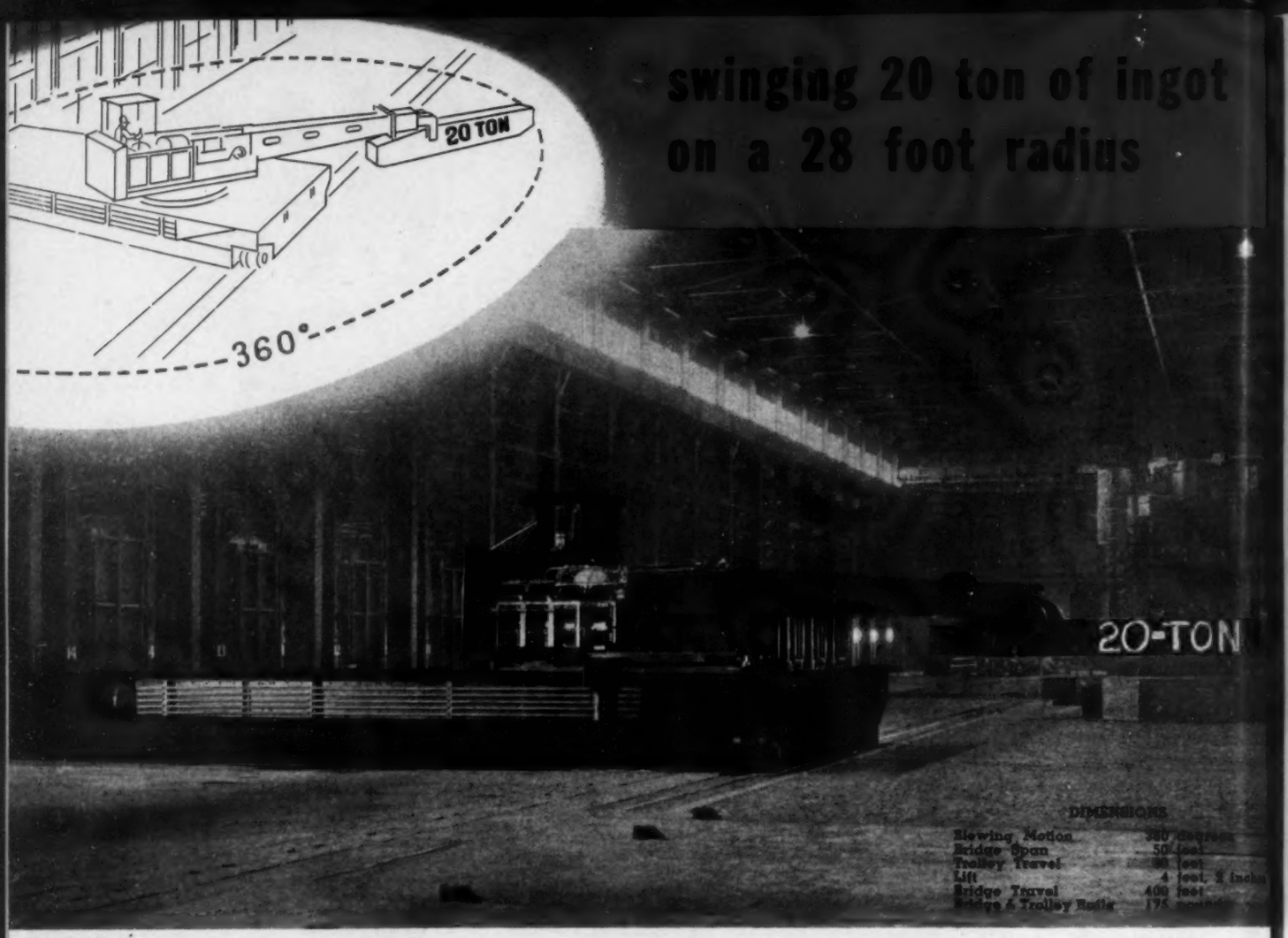
Where the going is tough specify "UNIVAN"—that tough steel. Union's long experience with alloy steels can be used to your advantage in whipping the "trouble jobs" of industry.

ARMY E NAVY

UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX CO. PITTSBURGH, PA.

MAKERS OF Driving Wheel Centers, Locomotive Frames, Pump Casings, Vault Doors and Frames, Annealing Boxes, Spindles, Coupling Boxes, Open Hearth Charging Boxes, Gear Blanks — and other Castings for Steel Mills and General Industry.



Alliance 20 ton crane designed and built by The Alliance Machine Co.

New Alliance Floor Type Ingot Charging Machine - - - one of the world's largest

● This Ingot Charging Machine shows that The Alliance Machine Company is still living up to its slogan—"The World's Largest Builders of the World's Largest Cranes." We have built into this machine features that have been developed and tested in the course of our 42 years of engineering and shop experience, and it is little wonder that when steel mill engineers are confronted with unusual problems, involving the handling of the smallest ingot to the 300 ton ladle of molten steel, that Alliance is consulted.

This machine is designed to grip, lift and swing a 20 ton ingot at a radius of 28 feet. The rigid cast steel upper revolving frame turns on conical rollers supported on a one piece cast steel lower frame so designed that the conical rollers operate in a bath of oil.

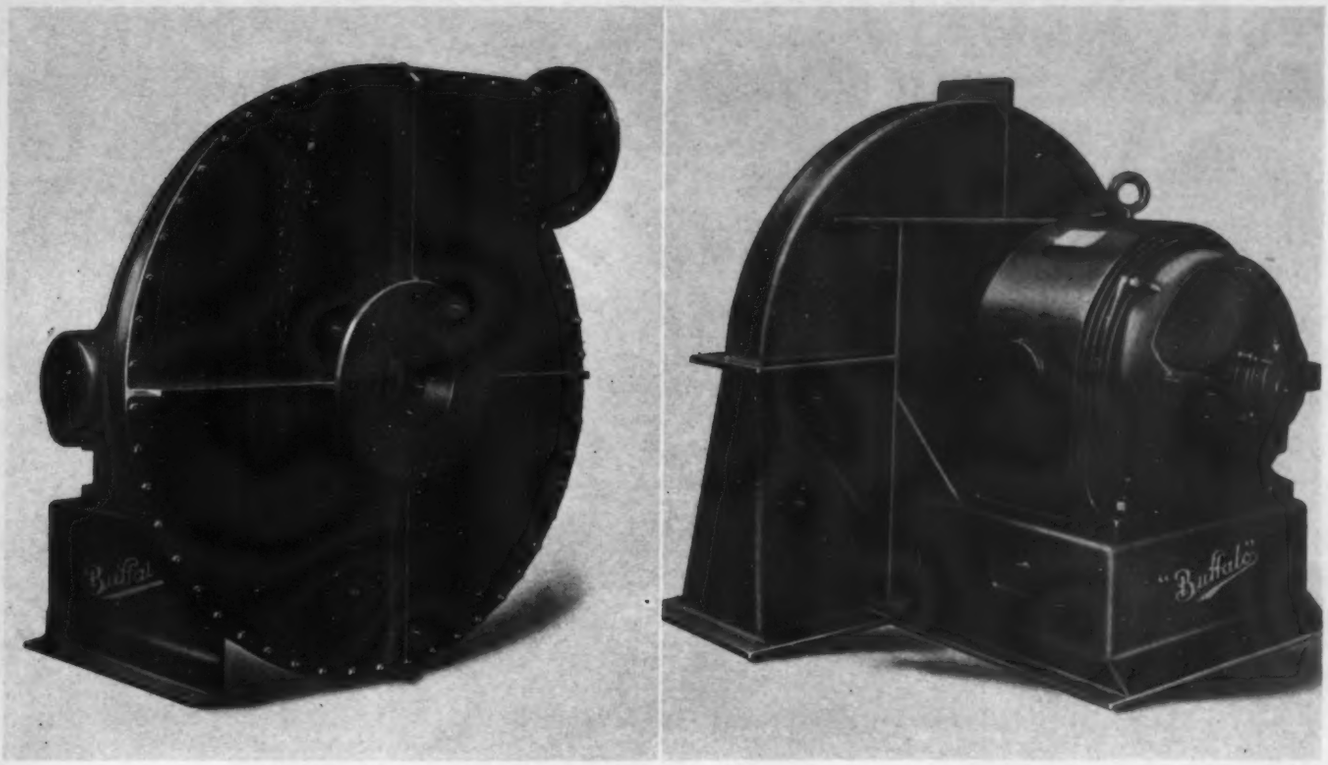
Great stability had to be provided in this Charger to successfully handle the heavy cantilever loads. This accounts for the ponderous sizes and 400,000 pounds of weight. Both the trolley and bridge are equipped with 8 rolled steel track wheels housed in cast steel compensating trucks. This construction provides smooth operation and reduces the wheel loading to a minimum.

An oil hydraulic system supplies the power for the hoisting and gripping cylinders. Contact rails located in a trench, under the bridge, supplies the necessary operating electric current.

ARMY E NAVY

Alliance

THE ALLIANCE MACHINE CO., ALLIANCE, OHIO - Pittsburgh Office: 1622 Oliver Building



New, improved performance at moderate cost....

Here are two new units developed by Buffalo engineers to meet the need for single stage high pressure centrifugal blowers and compressors, simple in design, rugged, practical — and moderate in cost.

Their design was made possible by research in the Buffalo Vacuum Test Pit, where rotor designs were tested at tip speeds as high as 50,000 to 75,000 feet per minute. All-welded heavy steel plate and aluminum alloy rotors are used.

These units are tailor-made to fit the requirements of the individual job — so that peak efficiency can be guaranteed. Buffalo Pressure Blowers can cut your air costs on many jobs.

NEW BULLETIN

There is now a new Bulletin No. 3553 at the Printers. This gives construction details and other data on centrifugal compressors and blowers. Write for your copy.

BUFFALO FORGE COMPANY

173 MORTIMER STREET BUFFALO, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo" "First For Fans"

Pressure Blowers

SPIN BATH CAN'T HURT IT

...It Can't Hurt Spin Bath!

THAT'S just *one* tough problem in *one* industry... textiles... buttoned up! For acid spin bath solutions must stay pure—or else the delicate synthetic threads may be ruined. "Karbate" spin bath tanks and heaters* *safeguard* this purity!

The non-contaminating property of "National" carbon, graphite and "Karbate" materials solves problems like this in many industries...

Non-contamination is assured, for example, using "National" carbon Raschig rings. It is of great importance to the success of chlorinating tubes for aluminum. "Karbate" scrubbing tower operations depend upon this quality. The same is true of carbon and graphite ingot molds, plugs and stools, or porous carbon filters.

But it is the unusual *combination* of physical, chemical and electrical properties that really gives "National" carbon, graphite, and "Karbate" materials their advantages over other materials. Inquiries are invited from the metals, chemical, mechanical, textile, electronic and other industries.

*Carbon or graphite made impervious to fluids under pressure.

BAR OF WHAT?

Carbon. Graphite, or "Karbate" materials. of course!

KEEP YOUR EYE ON THE INFANTRY... THE DOUGHBOY DOES IT!

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

General Offices: 30 East 42nd Street, New York 17, N. Y.

Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

The words "National" and "Karbate" are registered trade-marks of National Carbon Company, Inc.

Something to do about tomorrow—TODAY

Your responsibility doesn't *stop* with maximum war production. As a business man, you are a vital unit in the U. S. plan for economic reconversion. Don't wait for the "V" day whistles to wake you up.

Post-war America must market annually 140 billion dollars worth of goods and services—over 50% more than in any pre-war year. But our enlarged production facilities that make this *necessary* also make it possible to capture *quickly* product hungry markets of the world—as well as tap our own accumulated needs and savings.

Here are the makings of those 55,000,000 peacetime jobs. Here is the guarantee against run-away deflation.

YOU MUST BE READY . . . (1) Make a reasonable estimate of your needs to begin post-war business. (2) Place orders *now* for this material, to be delivered as soon as W.P.B. permits. (3) Advise your customers to do the same. (4) Keep up-to-date on governmental rulings.

With all manufacturers doing this, the transition period will be shortened and depression trends stopped . . . *Because* this plan permits suppliers to anticipate *your* needs and begin production on them at an earlier date. It gives *you* a back-log of orders to start you off and assures your quick return to civilian business.

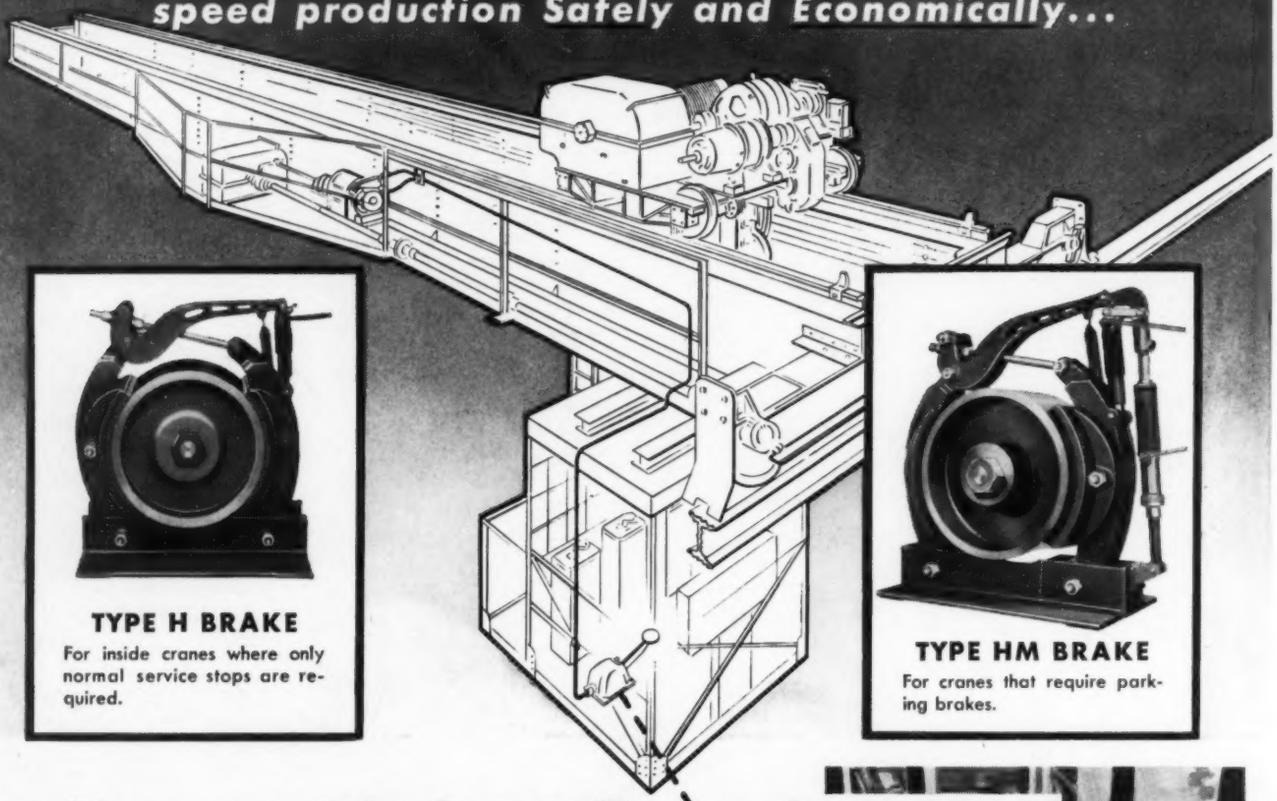
If you desire reprints of this advertisement without the Heppenstall name, mail your request to Heppenstall Co., Pittsburgh 1, Pennsylvania.

HEPPENSTALL, the most dependable name in forgings

Wagner

HYDRAULIC BRAKING SYSTEMS

speed production Safely and Economically...



TYPE H BRAKE

For inside cranes where only normal service stops are required.

TYPE HM BRAKE

For cranes that require parking brakes.

...make an easy job of controlling overhead cranes

When cranes are equipped with Wagner Hydraulic Braking Systems, heavy loads can be quickly and accurately stopped with the same ease as stopping your automobile—just a slight pressure on a foot pedal and the heaviest loads are quickly and accurately spotted.

They are used extensively, not only on overhead cranes, but also on bending rolls, scrap-balers, large wheel-balancers, and similar applications. They are easy to install and come to you in complete kits including everything necessary to make quick installation. For complete information write for Bulletin IU-20.

Wagner hydraulic braking systems simplify the handling of heavy crane loads. The illustration at right shows one of the twelve women operators handling cranes in a large midwest industrial plant.

145-1

Wagner

manufactures a complete line of Industrial Brakes, Motors, Transformers, and other products for industry.

Wagner motors are available in sizes and types for all industrial applications.

Wagner air-cooled transformers can be had for either indoor or outdoor installation. Wagner products also include distribution and power transformers as well as unit substations.

Wagner Electric Corporation

ESTABLISHED 1891

6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.

ELECTRICAL AND AUTOMOTIVE PRODUCTS

Engineered Heat with

SALEM CIRCULAR PITS

Complete automatic control of time, temperature, and furnace atmosphere, eliminates time-consuming checking of Salem Circular Pits. You can use your man power to expedite ingots to the rolling mill.

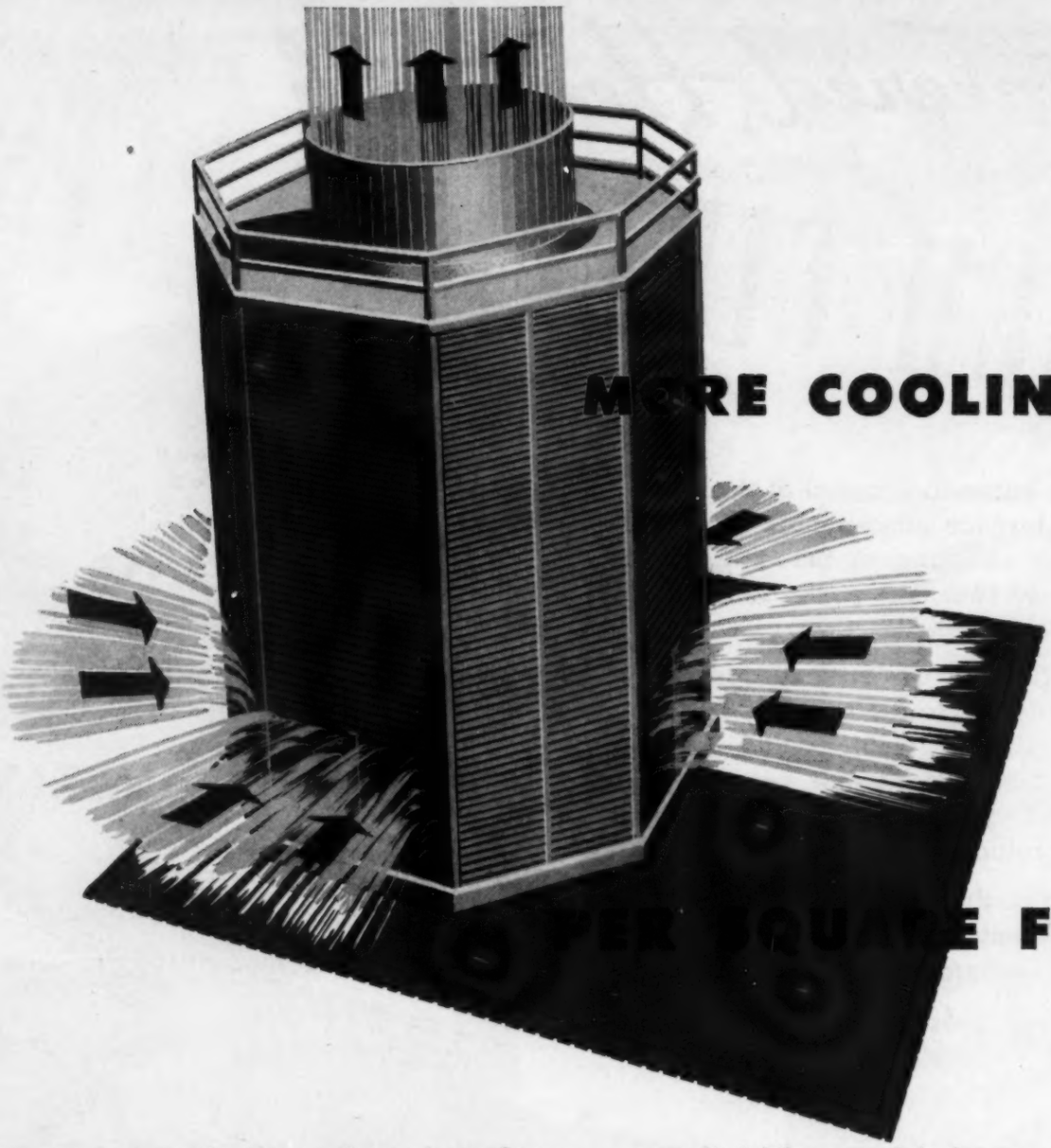
A Salem Circular discards all guesswork in preparing ingots. You merely set the control and the complete heating and soaking cycle is carried out. As a result, you can regulate your heating time in direct proportion to transit and rolling time.

Automatic control, uniform distribution of heat, and the many other features add up to one big point—*substantial savings of costs in every ton.*

Salem builds the Circular Pit in diameters between 8′ and 20′ utilizing any conventional fuel. This illustration shows 16′ Salem Circular Pits, an installation which replaced square pits to advantage.

Send Salem Your Soaking Pit Inqui

SALEM ENGINEERING CO. · SALEM, OHIO



Wherever you require the maximum in performance on a minimum of ground area, the FLUOR Counter-Flow Induced Draft Cooling Tower is the answer. Not only does it provide more cooling per square foot of base area... it makes possible a substantial reduction in the amount of concrete, reinforcing steel, other materials and labor since the basin required is also smaller.

The Fluor CFN Cooling Tower more nearly approaches the optimum efficiency of true counter-flow heat transfer. Due to new design water break-up is improved and air distribution better controlled. These result in longer and more thorough contact which gives each cell more cooling capacity than the old style conventional tower. Greater heat transfer per unit of ground space also reduces the number of fans and mechanical equipment required.

All designs for FLUOR Aerator Cooling Towers and FLUOR Counter-Flow Induced Draft Cooling Towers are fully protected by U. S. Patents and Patents Pending.

THE FLUOR CORPORATION, LTD.
2500 S. Atlantic Blvd., LOS ANGELES 22 • NEW YORK
PITTSBURGH • KANSAS CITY • HOUSTON • TULSA

SINCE 1890

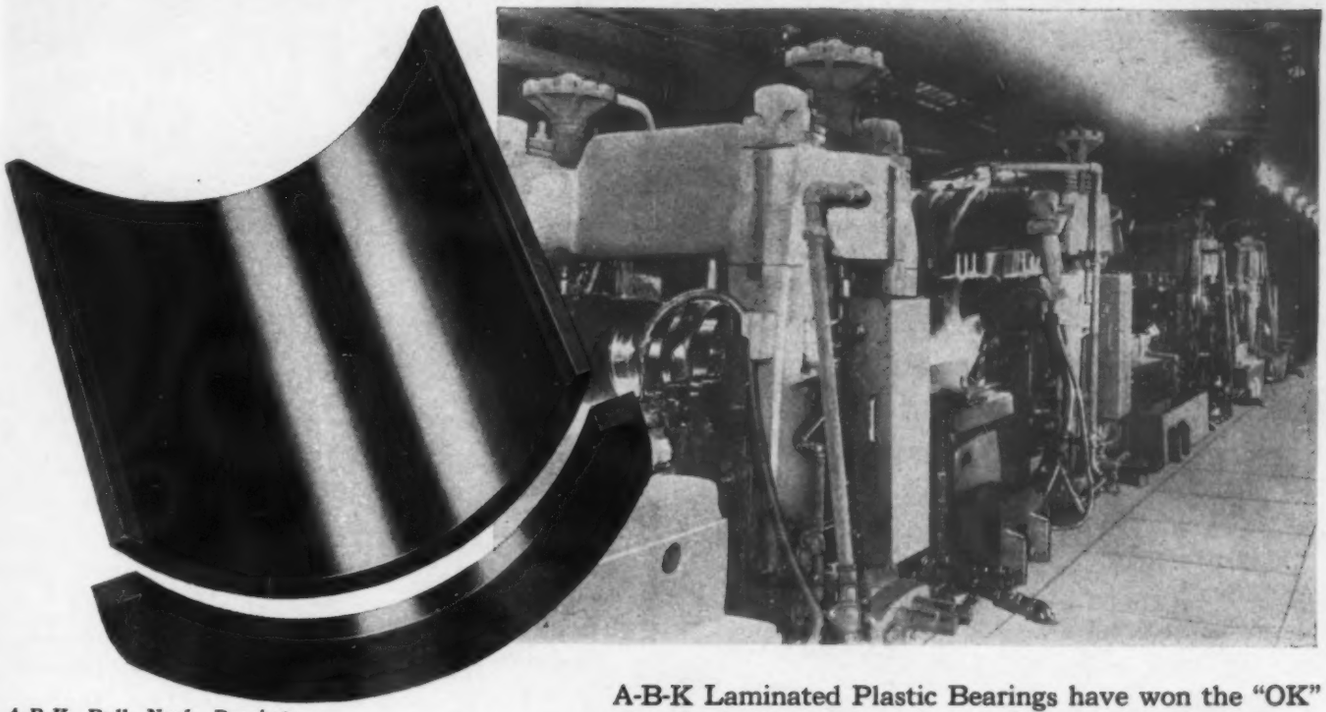
FLUOR

ENGINEERS • MANUFACTURERS • CONSTRUCTORS

Tonnage Goes Up—Power Costs Go Down

A-B-K

Laminated Plastic Bearings



A-B-K Roll Neck Bearing with separate collar.

A-B-K Patented Reinforced Edge Slipper Bearing made in required sizes to blueprints.

Phantom view of A-B-K Patented Reinforced Edge Slipper Bearing.

A-B-K Laminated Plastic Bearings have won the "OK" of many mill operators in today's record production.

More tons of steel per set of A-B-K Roll Neck Bearings—often 20 times as much as with metal bearings.

Savings up to 40% in power consumption are common in blooming, merchant and other steel mills using A-B-K Laminated Plastic Bearings.

A-B-K Roll Neck and Slipper Bearings were developed by A-B-K engineers to meet the specific problems of steel mill operators.

For information on your problem, phone, wire or write American Brakeblok Division, Detroit 9, Michigan.

American Brakeblok

DIVISION OF AMERICAN Brake Shoe COMPANY

Built by John Mohr & Sons, Chicago, Ill., these Monel crates handle steel sheet in pickling operations preparatory to galvanizing. Use of Monel assures long, safe service under corrosive conditions.

How many EXTRA FEATURES does pickling equipment need?

Here are answers that help steel mill speed output and reduce costs

A top-flight job, these crates...

Right now, all four are serving in the galvanizing department of a large mid-western steel mill.

Welded from Monel hot-rolled flat bar, each crate is 124" long and slightly under 40" wide. The sides are of ⅞" x 6" stock; cross members are of ½" x 3" bar. Corner supports are ⅜" x 2" x 21".

Chicago's John Mohr & Sons, prominent fabricators for steel plants, didn't have to hunt for a metal that was strong and tough. Or for one that could be readily fabricated.

They knew Monel's high tensile strength (80-95,000 psi for hot-rolled bar); they knew the inherent toughness which enables Monel to withstand stress and strain caused by load and impact.

They were aware that Monel provides superior resistance to the corrosive attack of pickling solutions other than nitric acid. And—almost equally important—they knew that the use of *standard mill forms* of Monel would result in savings to their customer, not only on initial cost, but later as changes, improvements or repairs were called for.

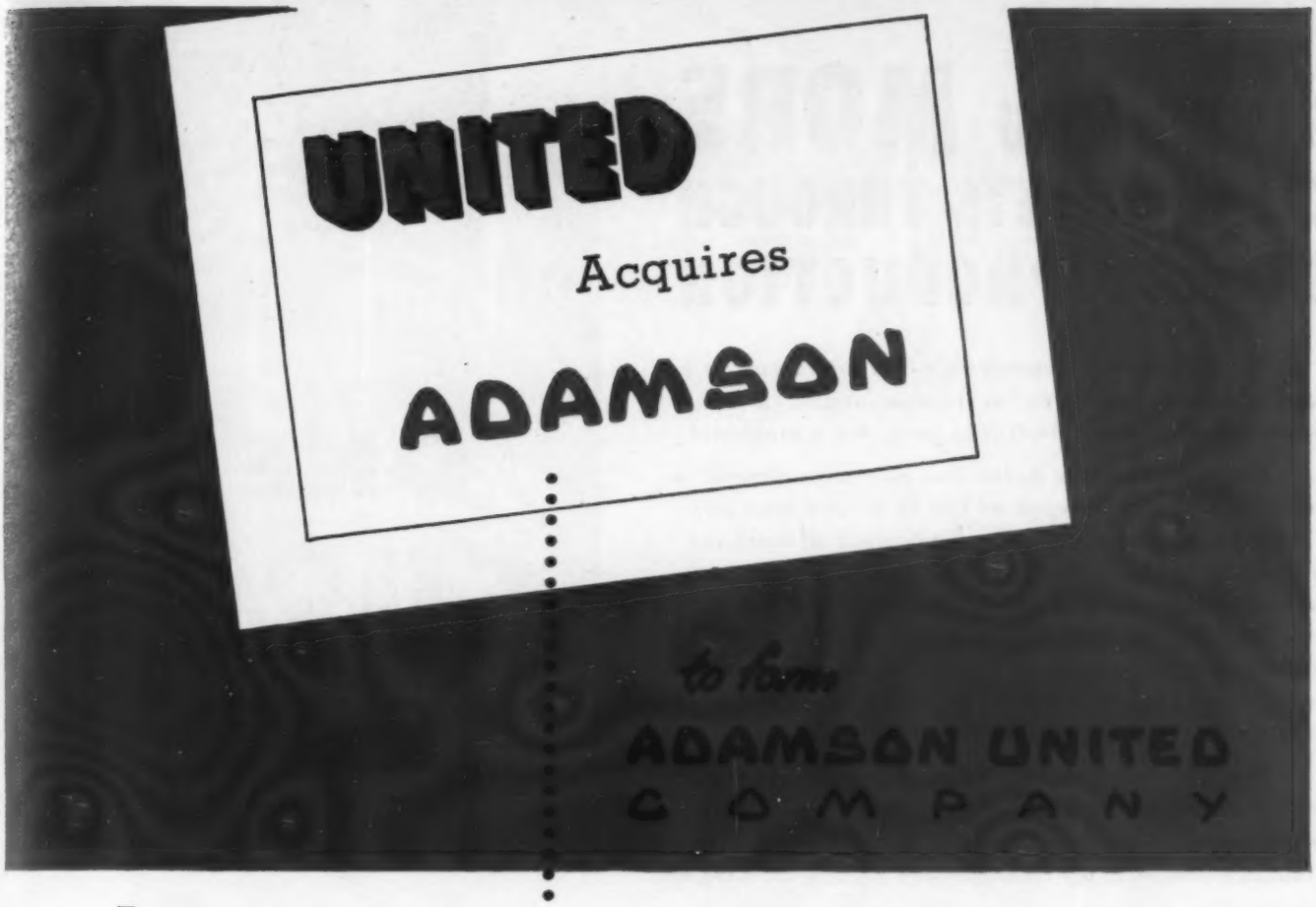
Those charged with responsibility for maintaining pickling room efficiency are invited to write for further information about the advantages and suitability of Monel in specific pickling applications.

MONEL

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL ST., NEW YORK 5, N. Y.

NICKEL (INCO) ALLOYS

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL
Sheet..Strip..Rod..Tubing..Wire..Castings..Welding Rods (Gas and Electric)



IN line with their policy of greater service to the rolling industry, UNITED ENGINEERING AND FOUNDRY COMPANY of Pittsburgh, Pennsylvania, have acquired the ADAMSON MACHINE COMPANY, located at 730 Carroll Street, Akron, Ohio.

Long and internationally known as one of the largest designers and builders of basic machinery for the Rubber, Plastics and Plywood Industries, this old established manufacturer will be known hereafter as ADAMSON UNITED COMPANY, a corporation chartered under the laws of the State of Ohio.

The new company, a wholly-owned subsidiary, will not only continue to engineer and build machinery for the manufacture of Rubber, Plastics and Plywood, but because of the additional facilities available, will have greater capacity for servicing existing equipment and a more comprehensive engineering service to offer the industry in the development of new processes and machinery.

***Products Manufactured by* Adamson United Company**

Calenders	Washers	Pot Heaters	Multi-Platen Presses
Mills	Driers	Ram Type Vulcanizers	Automatic Curing Presses
Mixers	Tubing Machines	Autoclaves	Belt Curing Presses
Refiners	Large Molds	Hydraulic Presses	Auxiliary Equipment

UNITED ENGINEERING AND FOUNDRY COMPANY
Pittsburgh, Pennsylvania

Plants at Pittsburgh, Vandergrift, New Castle, Youngstown, Canton

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**The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment*

GIVES YOU MORE CLEAN BILLETS THROUGH STEADY PRODUCTION

The Billeteer is dependable—it stays put. It has no ambitions, appetites, or temperament. It cannot be attracted to more desirable jobs. It's a machine!

The Billeteer is a billet cleaning department in itself. It will do the work of ten to fifteen men each 8 hour turn, thus giving the equivalent of approximately 40 men, single turn. This speeds output and cuts chipping costs. Further, the Billeteer makes possible the use of billets from bad heats by speedily cleaning up deep flaws; removal of these by manual chipping would be prohibitively expensive.

The Billeteer makes billet-cleaning a semi-skilled job and allows the operator a degree of pride in his work. This one factor of human nature contributes tremendously to employee loyalty and steady production.

The Billeteer is a preferred production investment which we feel you should investigate thoroughly. On your request we will send an illustrated brochure, and refer you to executives whose plants use Billeteers.

ADDRESS CORRESPONDENCE TO THE
STEEL EQUIPMENT DIVISION

Engineered for
Bonnot
THE BONNOT COMPANY
CANTON, OHIO
BUILDERS OF **THE BILLETEER**

MECHANIZE YOUR BILLET CONDITIONING NOW!

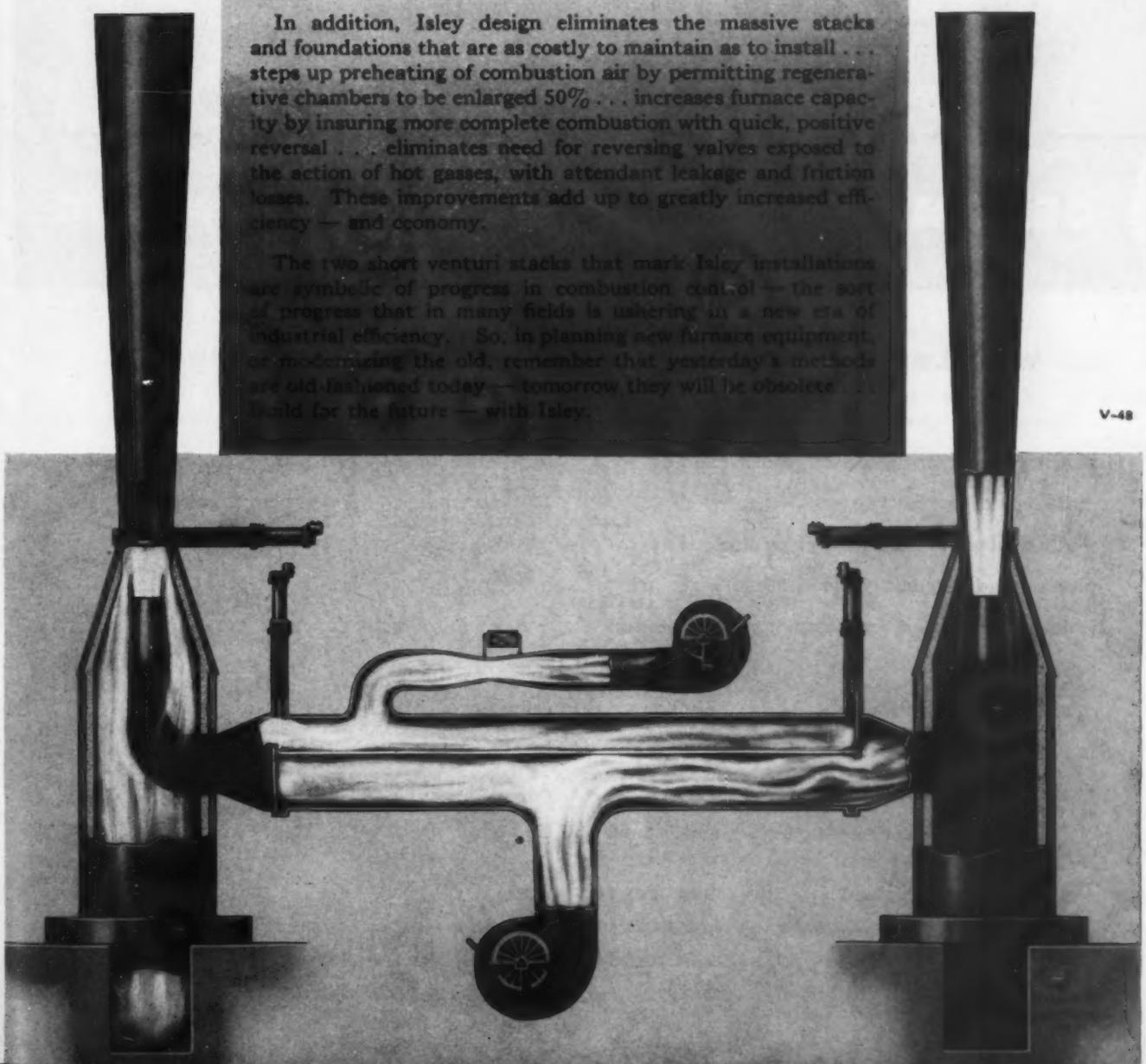
WE DID SOMETHING ABOUT THE WEATHER...

In fact, the Isley principle of *controlled* draft entirely does away with weather as a factor in industrial furnace operation. Two balanced fans "push-pull" a constant, even flow of air throughout the entire furnace system, regardless of snow, rain, temperature or other external conditions that strongly affect natural draft furnaces.

In addition, Isley design eliminates the massive stacks and foundations that are as costly to maintain as to install . . . steps up preheating of combustion air by permitting regenerative chambers to be enlarged 50% . . . increases furnace capacity by insuring more complete combustion with quick, positive reversal . . . eliminates need for reversing valves exposed to the action of hot gasses, with attendant leakage and friction losses. These improvements add up to greatly increased efficiency — and economy.

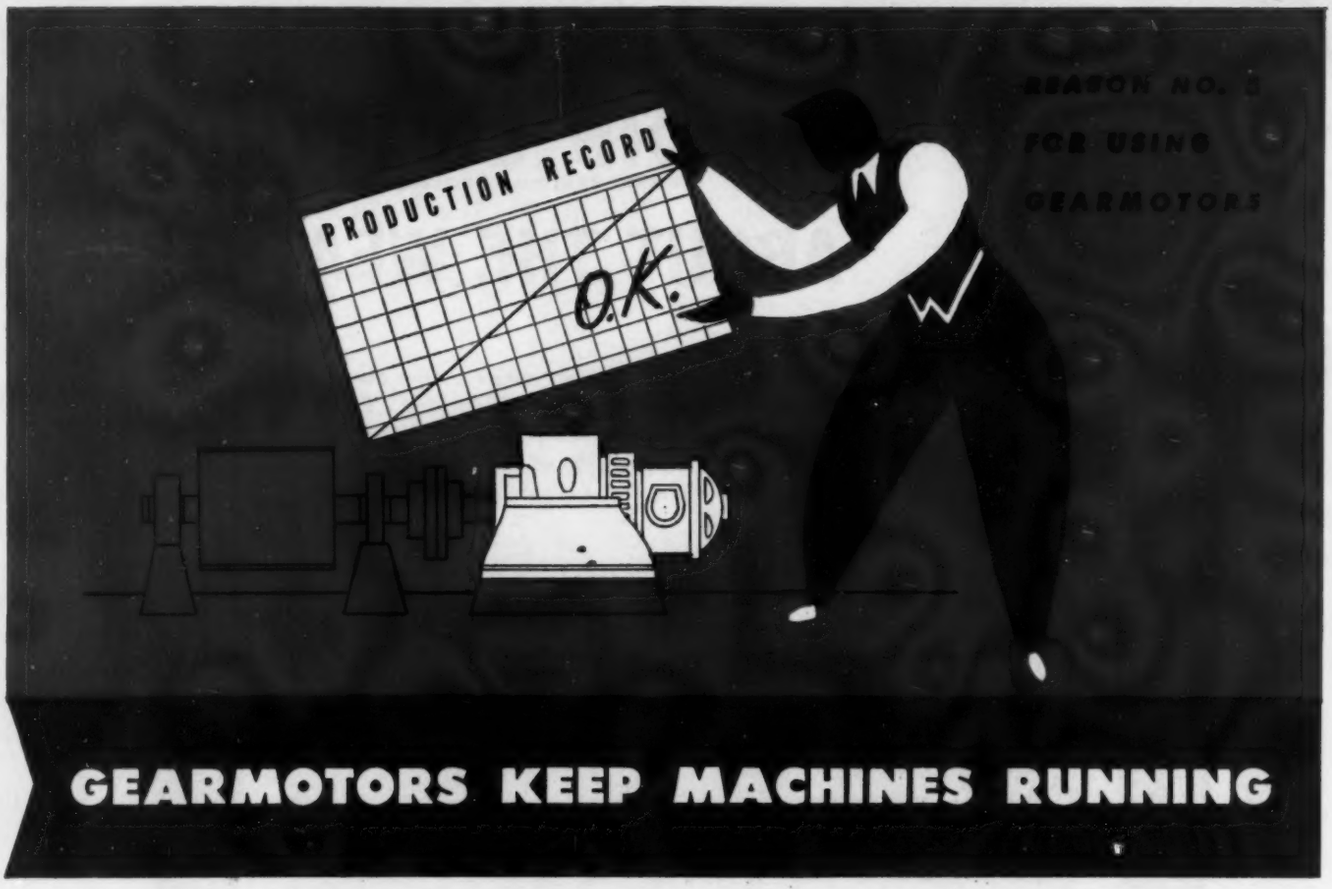
The two short venturi stacks that mark Isley installations are symbolic of progress in combustion control — the sort of progress that in many fields is ushering in a new era of industrial efficiency. So, in planning new furnace equipment or modernizing the old, remember that yesterday's methods are old-fashioned today — tomorrow they will be obsolete. Build for the future — with Isley.

V-48



MORGAN CONSTRUCTION COMPANY, Worcester, Massachusetts

ENGLISH REPRESENTATIVE: INTERNATIONAL CONSTRUCTION CO., 56 KINGSWAY, LONDON, W. C. 2, ENGLAND



GEARMOTORS KEEP MACHINES RUNNING

with Less "Time Out" for Maintenance and Repairs

Gearmotors give trouble-free, uninterrupted performance that keeps machines running for *more* productive hours.

A machine powered with a gearmotor is a complete, operating unit. This eliminates recurring problems of repair, replacements and tension adjustments . . . as well as frequent realignment of separate units. With a gearmotor, maintenance is a minor factor. A periodic change of oil in the gear case is about all that is necessary.

A gearmotor combines motor and speed reducer in a *single* unit . . . which assures high efficiency and smooth-running operation. It delivers the horsepower required, at the speed needed—with nothing else to buy for many years.

Ask your Westinghouse representative about this and the many other basic advantages of gearmotors. All of these are discussed in detail in a new handbook, "Gearmotor Applications". Ask for B-3218. Westinghouse Electric & Mfg. Company, P. O. Box 868, Pittsburgh 30, Pa.

J-07225

REASON NO. 1—GEARMOTORS SAVE SPACE
REASON NO. 2—GEARMOTORS SIMPLIFY SELECTION, ORDERING, DELIVERY
REASON NO. 3—GEARMOTORS SAVE INSTALLATION TIME AND EXPENSE
REASON NO. 4—GEARMOTORS REDUCE LOSSES IN POWER TRANSMISSION

One of a series sponsored by Westinghouse to promote the use of gearmotors

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

10 REASONS why

it pays to install *WESTINGHOUSE* Gearmotors

1. FEWER PARTS TO WEAR. The simple, efficient design employs a minimum of moving parts.

2. BPT "TOUGH-HARD" GEARS AND PINIONS. This exclusive Westinghouse heat-treating method "tough-hardens" teeth for maximum resistance to shock and impact—means longer wear.

3. USE ALL WESTINGHOUSE MOTOR TYPES—open . . . totally-enclosed . . . splashproof . . . explosion-proof—to meet changes in operating conditions quickly and easily.

4. INTERCHANGEABILITY OF PARTS between unit types reduces your parts' replacement stock by 40%.

5. HIGH EFFICIENCY of gearing parts assures full motor horsepower at output shaft . . . only 2% power loss per gear set.

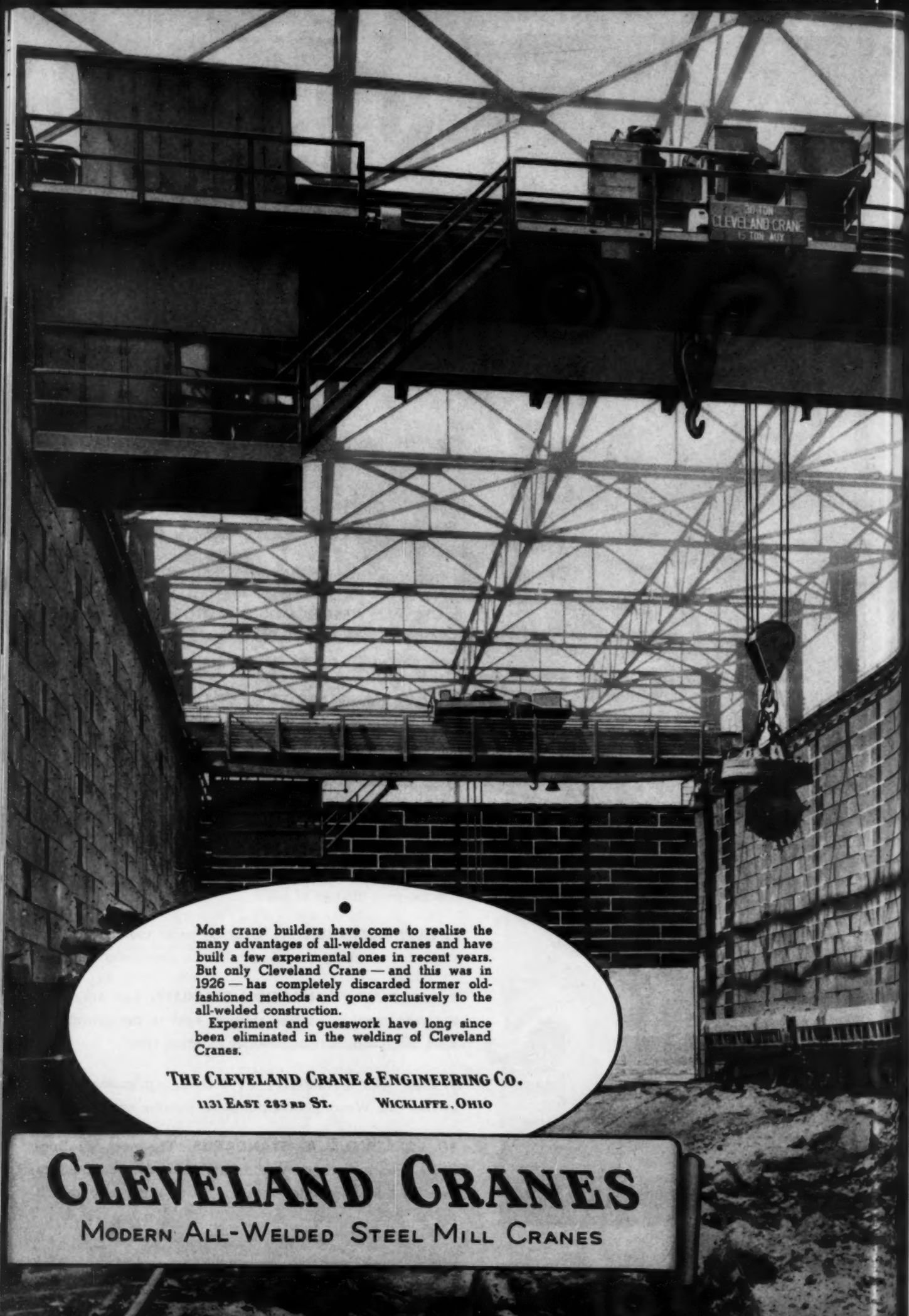
6. POSITIVE LUBRICATION of gears and bearings by automatic splash system reduces probable maintenance to twice-a-year change of oil.

7. EASY ACCESSIBILITY. Gearing parts can be readily inspected or easily removed to make gear ratio changes.

8. IMPROVED FOUNDATION STABILITY. Feet are under the gear case . . . placing support next to the gearmotor load. Each foot is reinforced by external ribs.

9. UNIT RESPONSIBILITY for design . . . manufacture . . . and service. Westinghouse builds both motor and the gears.

10. MEET A.G.M.A. STANDARDS. The new Westinghouse Gearmotors are specifically designed and built to meet A.G.M.A. standards . . . easy to order and match to the job.



Most crane builders have come to realize the many advantages of all-welded cranes and have built a few experimental ones in recent years. But only Cleveland Crane — and this was in 1926 — has completely discarded former old-fashioned methods and gone exclusively to the all-welded construction.

Experiment and guesswork have long since been eliminated in the welding of Cleveland Cranes.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

WORKERS in some plants and mines had a brief taste of depression experience when they gazed at "No work tomorrow" signs posted late last month. No depression, however, but merely the result of a three-day embargo on the movement of freight other than "essential war material" ordered by one bureau of government which was meanwhile striving to put all men into universal service so as to obtain manpower to bolster war production. Subsequent modification of this poorly conceived move came too late to prevent the boomerang results — coal mines shut down because of no empty cars for loading, electric furnaces and open hearths down for lack of limestone, etc., finishing mills down for lack of shipping facilities.

▲

IT'S costing us a lot of lives and money to convert the Jap war machine back into the junk they bought from us.

▲

THERE seems to be some danger of the pendulum swinging from over-optimism to excessive pessimism. The current unpopularity of discussions of post-war plans cannot, however, be allowed to stop all such planning or any hope of a reasonably smooth transition to peacetime production will vanish.

▲

ALTHOUGH guesses about the date of victory, particularly by military or government personnel are now considered definitely bad taste, armchair experts estimate that the reduction in the annual budget from 88 to 70 billion dollars indicates a thinking toward VE day in summer or early fall.

▲

ONE of our agents reports a sign in a butcher shop: "Ladies will please not bring in their fat cans on Saturdays."

▲

FINAL reports show total steel production for 1944 as 89,552,961 tons, made up of 80,354,771 tons from open hearths, 4,158,040 tons from electric furnaces, and 5,040,150 tons of bessemer steel. This represents a gain of more than 700,000 tons over 1943 production.

▲

THE salaried worker — truly the forgotten man for too many years — is finally going to get a raise if the War Labor Board grants National Steel's request for a 5 per cent increase retroactive through 1944.

▲

IT'S difficult to determine which is harder on one's constitution, smoking cigarettes or trying to get them.

▲

WHILE most of us would gladly trade one dollar for several thousand a week, we are in hearty accord with Cecil B. DeMille in his fight to overthrow the principle that an organization can deprive an American citizen of his livelihood because of political disagreement — and that is the basic premise of his being barred from radio work for refusing to help finance a fight against his own political convictions.

▲

APPROXIMATELY 100,000,000 antifriction bearings of all types and sizes were manufactured in 1944 for the aircraft industry alone. Each Flying Fortress contains 3141 bearings of all types, while the Lightning has 2138 and an ordinary training plane, 401 bearings.

▲

IF you've been eating in restaurants or dining cars lately, you've probably guessed it already, but the Boston manpower commission has declared dishwashers essential and chefs unessential.

▲

IT is estimated that iron ore stocks at the steel plants will be down to 7,000,000 tons by spring, less than half of the usual figure. This decrease in stocks is to some extent premeditated, as production and shipment of Lake ores in 1944 were purposely reduced so that excessive stocks would not be carried over. The 1944 ore movement on the Great Lakes closed November 28, the earliest closing date since 1919. The recently completed coast guard icebreaker Mackinaw (5090 tons, $10,000,000), however, is said to be capable of opening Great Lakes navigation three weeks ahead of Mother Nature's action.

▲

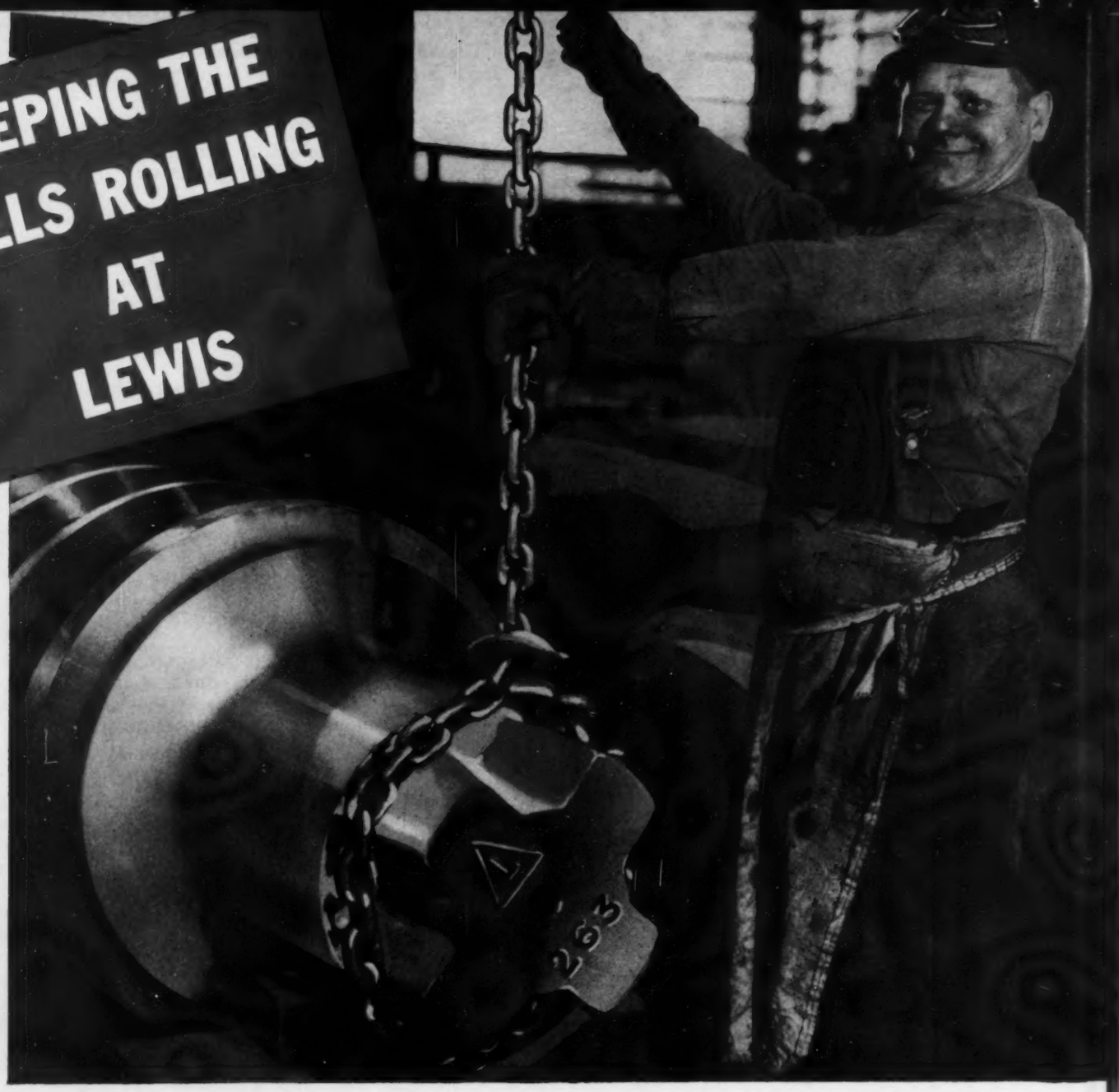
MORE serious is the coal situation, with stocks in the industry down as low as a 15-day supply or less in the majority of plants. Severe winter weather and a shortage of manpower have contributed to this and the freight embargo topped it off. WPB's Iron and Steel Industry Advisory Committee has expressed concern, particularly in view of the fact that union contract arrangements between coal operators and miners, which expire March 31, may possibly bring further interruption in coal production.

▲

ALL of the steel companies have extensive plans for modernization and improvement of old equipment when conditions permit, but Carnegie-Illinois Steel Corporation is the first to break the ice with an announcement of their proposed expenditure of $50,000,000 at Gary works.

▲

ISN'T it remarkable that people who agree with us are always such sensible persons?



This Charlie Hopey is quite a Guy!

★ ★ ★ ★ ★ ★

Charlie, now 58 years young, has been with Lewis for 21 years and still takes pride in his job as a hand finisher on rolls. Charlie's record at the plant is a fine one—Take a look at his Service Flag too! *Six sons in the armed forces!* . . . a 17-year-old with a Naval Hospital unit in the East . . . a 20-year-old in the South Pacific . . . a 22-year-old with the Navy in European waters . . . a 23-year-old and a 24-year-old in the European invasion operations . . . a 26-year-old in Hawaii.

Next time you install a new Lewis Roll take a look at that fine finish —it might be the work of Charlie Hopey!

LEWIS FOUNDRY & MACHINE DIVISION
of BLAW-KNOX Company, Pittsburgh, Pa.

SAM E NAVY

Also manufacturers of
ROLLING MILL MACHINERY
for the iron, steel and
non-ferrous industries

LEWIS ROLLS

Pressure, Heat and Water–

NEW GREASE LICKS THEM ALL!

HERE on table roll bearings—and on work and back up roll bearings—the three major enemies of lubrication are crushing pressures, excessive temperatures and the washing action of water.

Socony-Vacuum's new patented grease for steel mill service—Gargoyle Grease Sovarex L—sticks on the job despite all of these destructive forces—prolongs the life of vital bearings—keeps maintenance and lubrication costs down to a minimum.

Operators now using this new grease report that it stands up under heavier pressures than any other grease and resists softening under temperatures as high as 450° F. "Downtime" for bearing repairs and replacements has been materially reduced, production increased.

Gargoyle Grease Sovarex L, is an exclusive Socony-Vacuum product, developed especially for steel mills. Get performance facts and figures from your Socony-Vacuum representative.

SOCONY-VACUUM OIL CO., INC.
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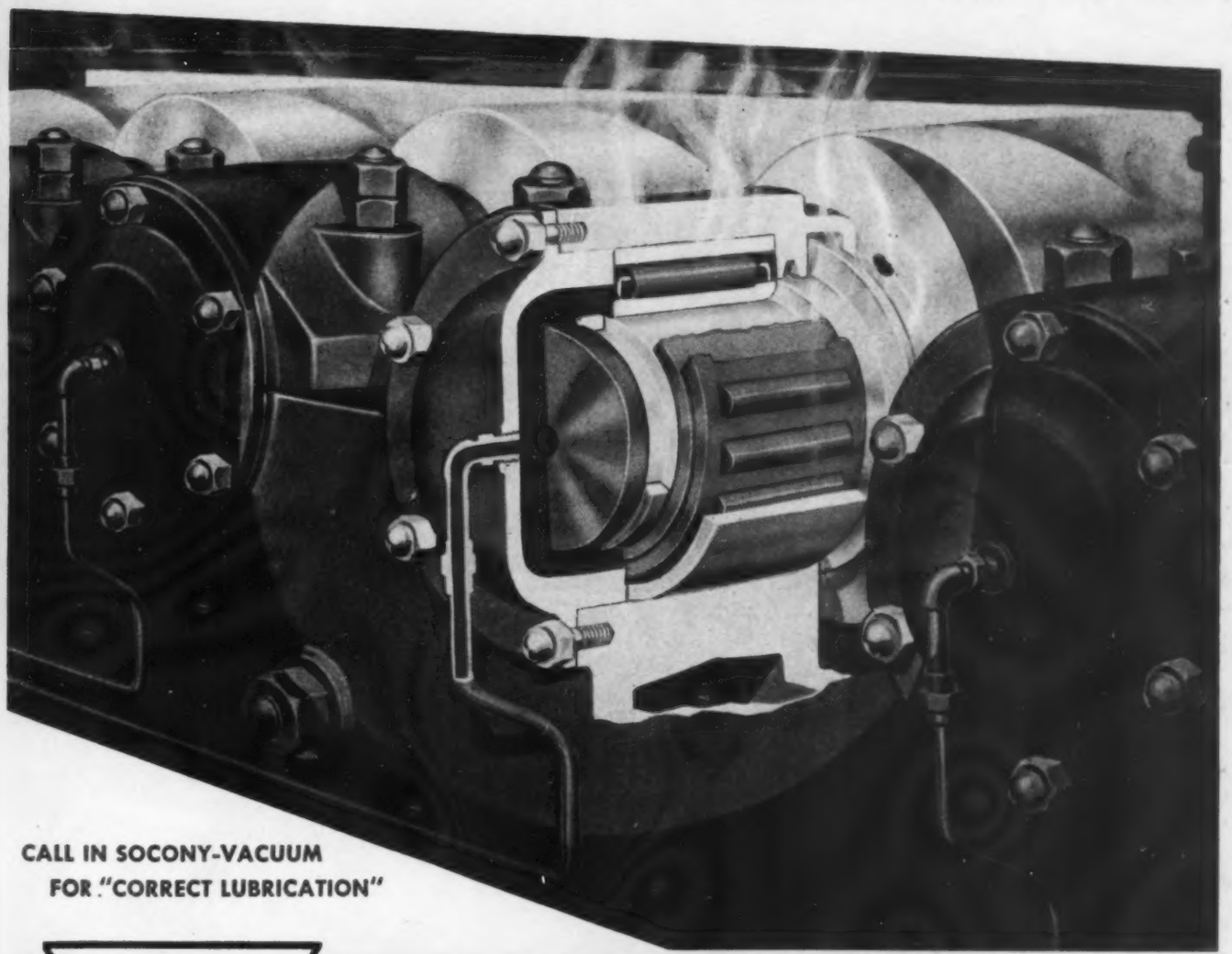


CALL IN SOCONY-VACUUM FOR "CORRECT LUBRICATION"

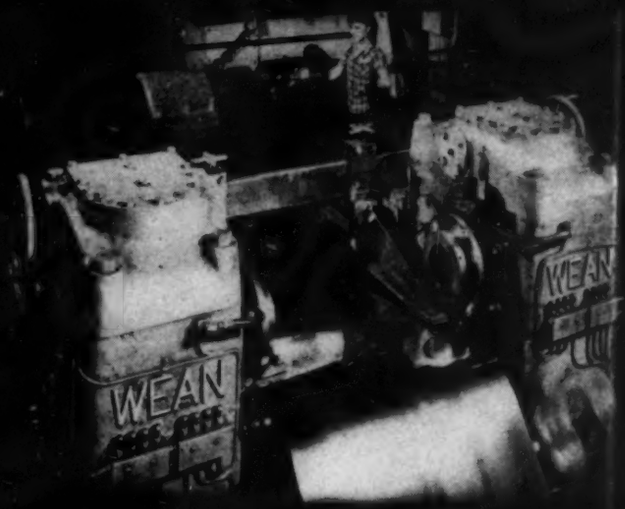
GARGOYLE Lubricants

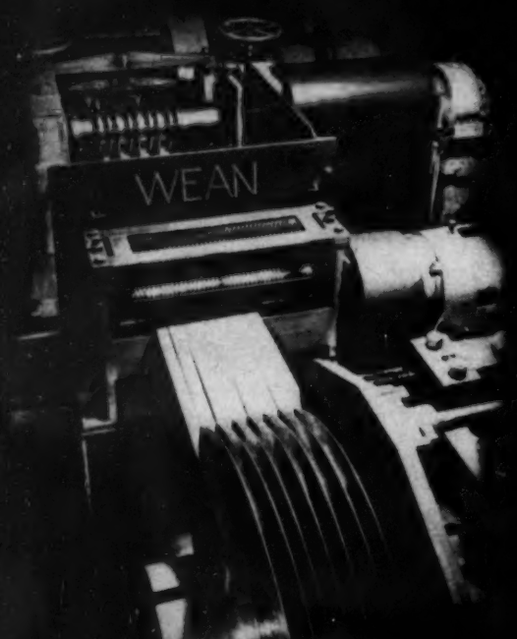
Socony-Vacuum's FIVE STEPS to Lower Production Costs for You

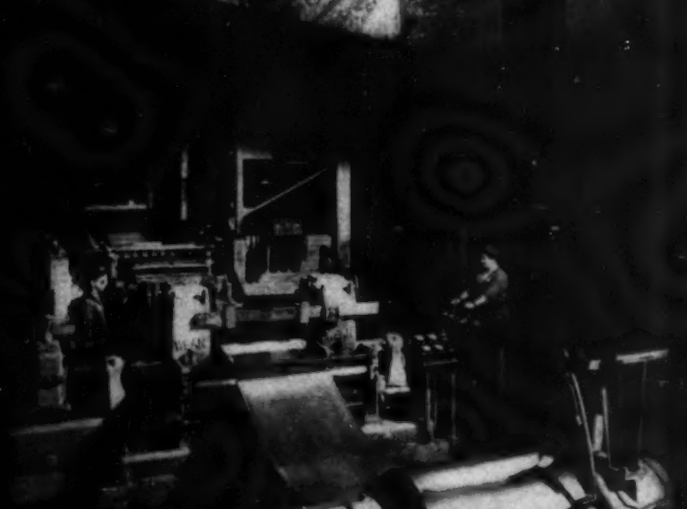
1. Lubrication Study of Your Entire Plant
2. Lubrication Schedules and Controls
3. Lubricant Storage and Handling System
4. Skilled Engineering Counsel
5. Progress Reports of Benefits Secured

WEAN

SHEARING, SIDE TRIMMING AND SLITTING EQUIPMENT for STRIP STEEL







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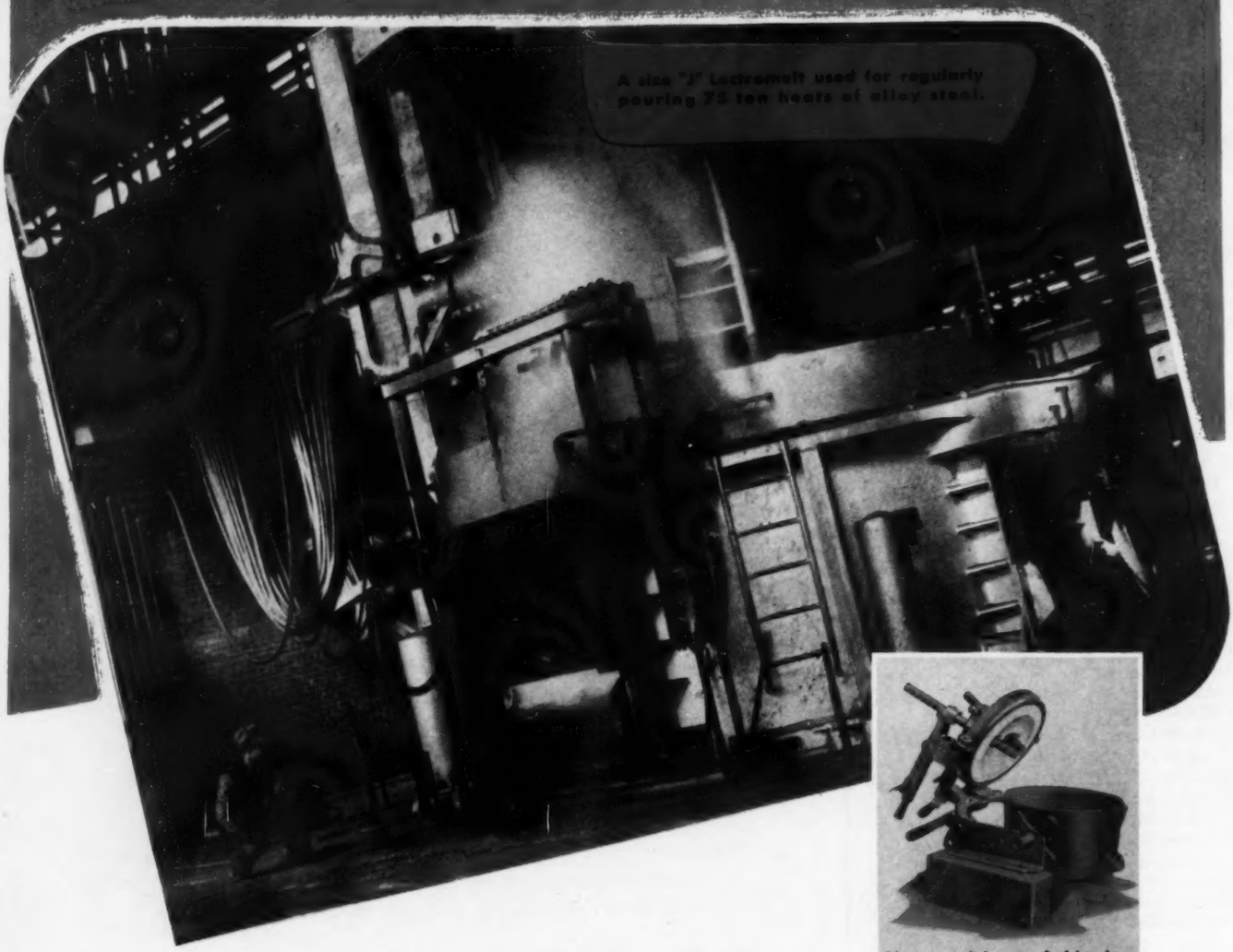

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Structural Mills AND STRUCTURAL Roll Designing

. . . . describing structural mill layouts, pointing out the progress in the rolling of structural materials, and outlining some of the roll designs used in structural mills . . . .

by ROSS E. BEYNON

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▲ STRUCTURAL mills are generally designated as those which roll structural shapes as their principal product, although on many mills of this kind, other commodities may be produced, such as sheet piling, rails, tie plates, angle splice bars, rounds, squares, flats and various small sections. While shapes of the smaller sizes are also regularly produced on a large number of merchant bar mills, this paper will be confined to discussion of structural mills and structural shapes with a few interesting exceptions.

The first rolling mills in operation were designed for flat bars or sheets. Cort later invented the grooved roll mill, on which flat material as well as rounds and squares were produced. Structural shapes were not introduced until 1819, when the rolling of angle iron was developed at the Union Rolling Mill in Pittsburgh, Pennsylvania.

In 1849 the first I-beams were rolled in France on a mill which produced 5½ in. beams. The first of such product rolled in this country was reported to have been produced at Trenton, New Jersey, in 1854. These beams were 7 in. deep. Curiously enough, the mill used for the beams was a three-roll vertical mill. The first Z-bars produced were rolled in Germany in 1863. In 1867 Kloman built a 20 in. structural mill which produced the first beams made at Pittsburgh, Pennsylvania. Nearly a decade later, in 1876, Joseph DeBuigne rolled the first H-beams, 3.15 in. x 3.15 in. in a continental mill by what was probably the first use of the diagonal method of rolling.

The structural shape business as we know it today was developed from these initial rollings. The first mills used to produce shapes had rather small diameter rolls, inadequate for rolling the larger sections, although 12 in. and 15 in. beams were rolled in 1884 on a comparatively small mill at Pittsburgh. Other mills, of special design for structural materials, were later built in various parts of the country, some of which are herein described.

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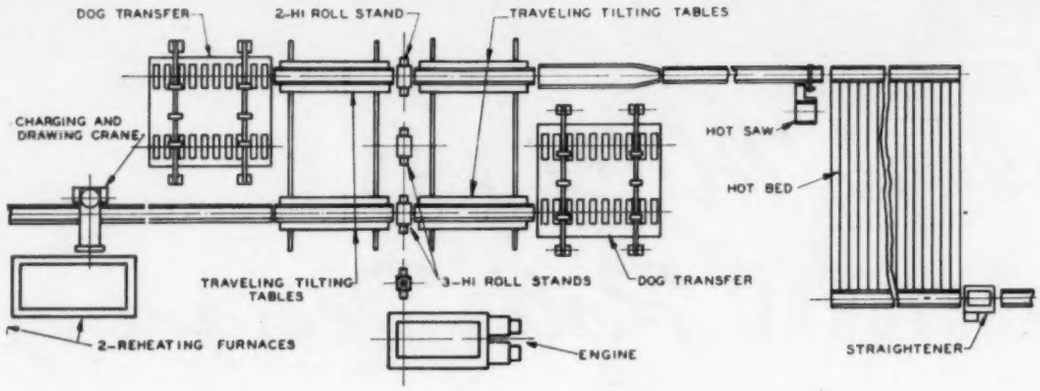
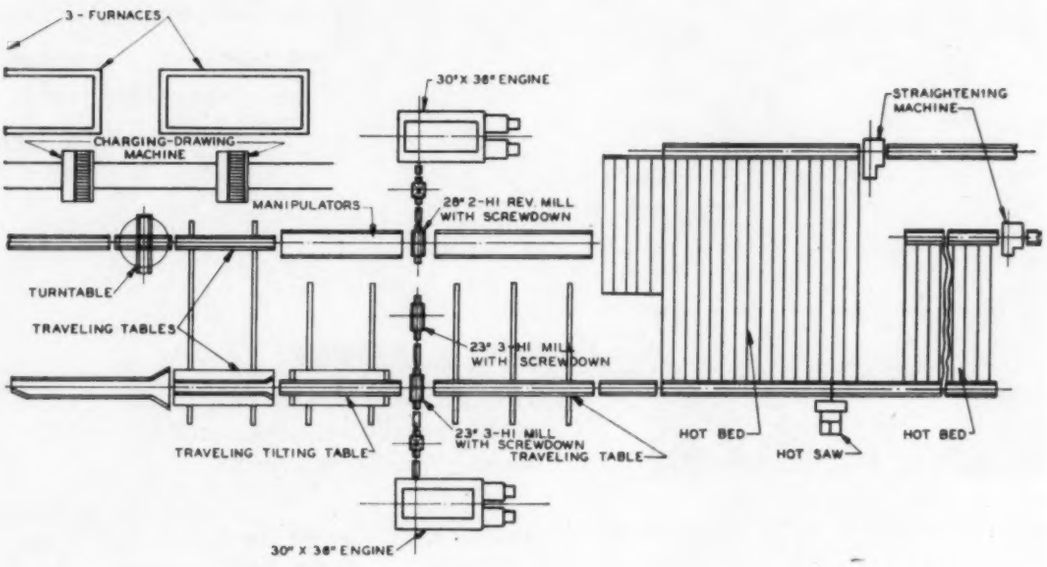
STRUCTURAL MILLS

A structural mill having three or four stands in line, with traveling tilting tables (Drawing 1) for rolling large sections, operates with slow rolling speed. The heavy drafts used on structural shapes in the first passes are possible only with relatively slow speeds, and with more than one bar in the mill at a time, the roughing speed necessarily governs the finishing speed. Even with variable speed motors the tonnage will be restricted by the number of passes required to roll the section, and by the rather slow average speed of operation.

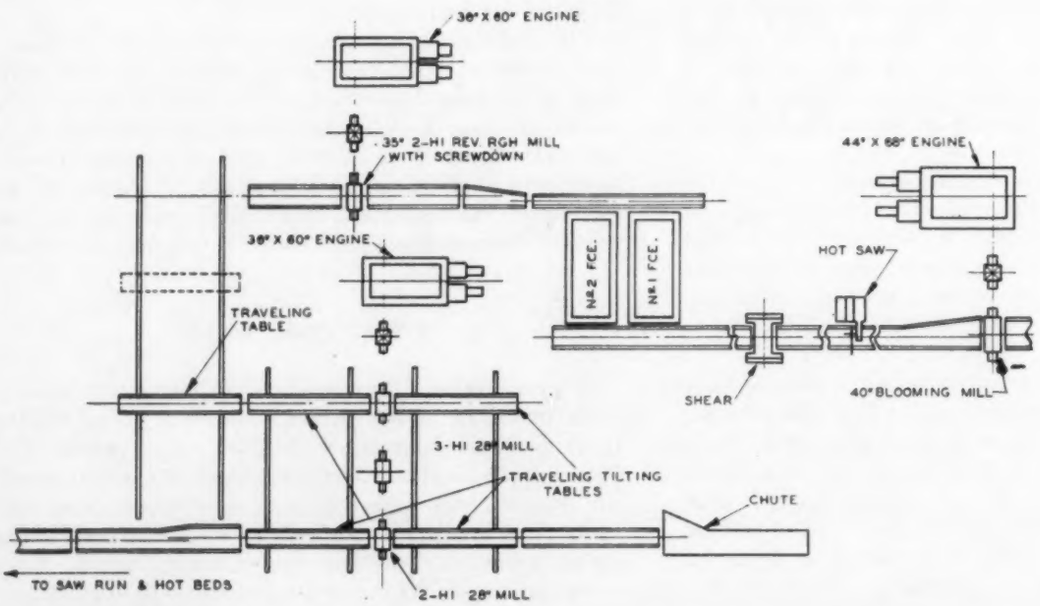
Stationary tilting table arrangements have been



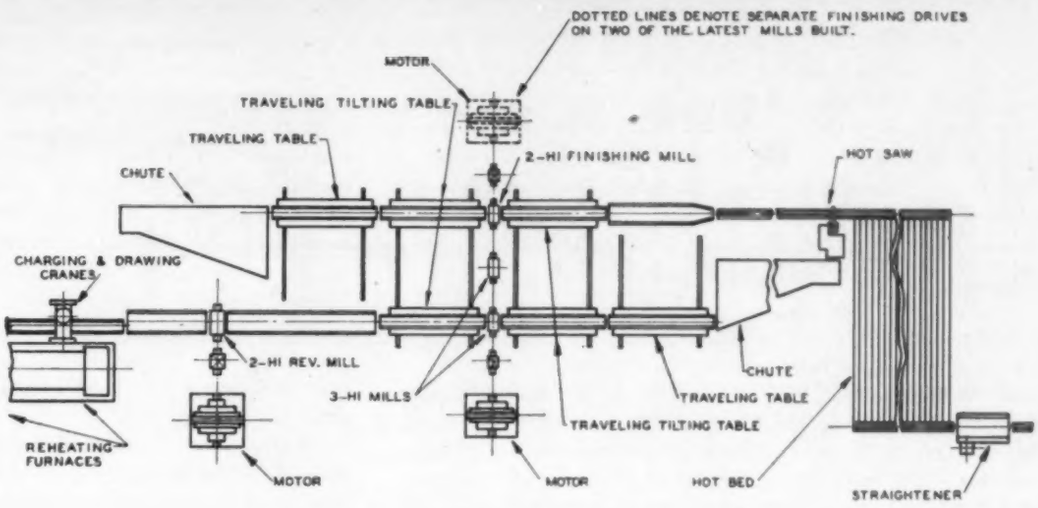
Drawing 1 — Layout of early type structural mill with traveling tilting tables.



Drawing 2 — Early 23-28 in. structural mill with separate drive for roughing stand.



Drawing 3 — Layout of structural mill with separate two-high reversing breakdown stand.



Drawing 4 — Another structural mill using a separate two-high reversing breakdown in line with the three-high rougher.

provided in some mills of this type and permit rolling two or three bars in the mill simultaneously with fair results in increased tonnage, but these mills are still handicapped by speed limitations. The roughing and finishing speeds are the same, and since it is difficult to take heavy drafts at high speed, the finishing speed must be adjusted to suit a practical roughing speed. This handicap was recognized and as a result a number of mills were built with separate roughing stands. The latter could operate at a relatively slow speed while the finishing mills operated at a much higher speed.

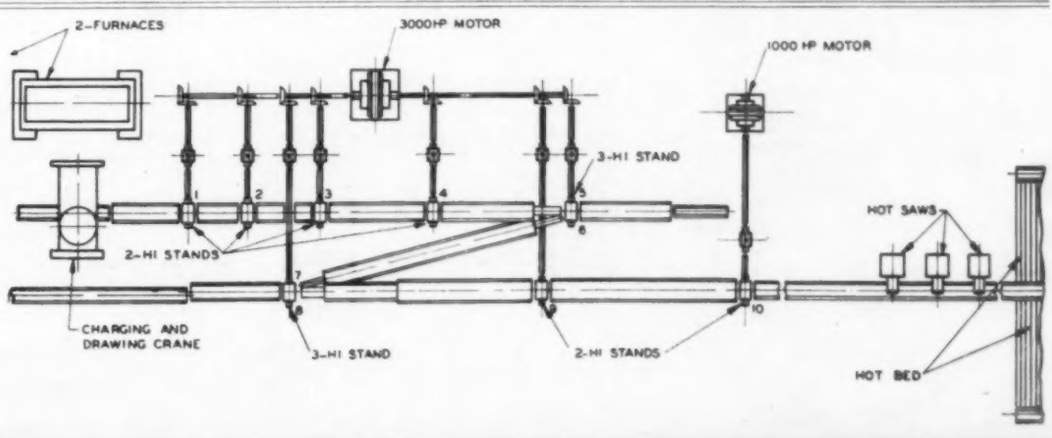
One of these early and now obsolete installations is illustrated by Drawing 2. It will be noted that the two-high roughing stand was in line with the intermediate and finishing stands, but operated by a separate engine. This roughing mill was a two-high reversing stand with a screwdown, in which bars could be worked more than once through the same pass.

The intermediate and finishing stands also had screwdowns, although the stands were three-high. The requirement for the screwdown on the intermediate and finishing stands was due to the mill being of 23 in. dimension and too weak for heavy drafting; also because beams as large as 24 in. in size were rolled, it was necessary to roll more than once in each pass to lessen the draft.

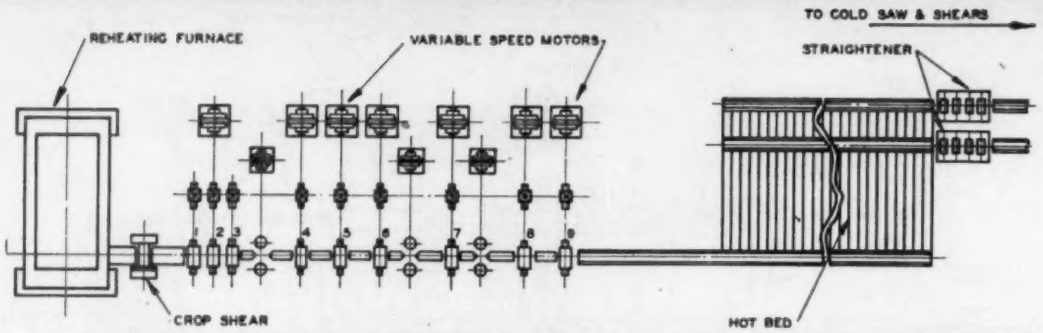
Another design, somewhat similar, is illustrated in Drawing 3. In this case, the finishing mill had three stands of 28 in. diameter rolls, and the breakdown, which was farther away from the finishing mill than in the design shown by the previous drawing, was a 35 in. two-high reversing mill with screwdown. The blooming mill runout table ran directly back of the reheating furnaces, with the furnaces taking the steel in the back and discharging the reheated blooms directly onto the 35 in. mill approach table.

From these early designs a more modern mill was developed, such as is shown by Drawing 4. This design illustrates a two-high breakdown mill located in front of the finishing mill and nearly in line with the roughing stand, thus providing a more direct operating sequence. This has proved to be a very fine arrangement of stands, and the only improvement to date on the original 1906 design has been made in two recent installations in which the finishing stand is driven by a separate motor. For large and medium sized standard or special shapes, this type of mill is the best design that has been developed to date.

In the effort to secure large tonnages, various mill layouts have been devised. One of the most popular of these is the so-called cross-country mill. The arrangement of stands for a mill of this type is such that the bars are never in more than one stand at a time, even though there may be six or seven bars in the mill at various stages of rolling. Drawing 5 illustrates a mill of this design. Obviously, with five to seven bars in the



Drawing 5 — The cross-country layout for a structural mill gives high capacity.



Drawing 6 — Light weight structural sections are rolled in merchant mills of this type.

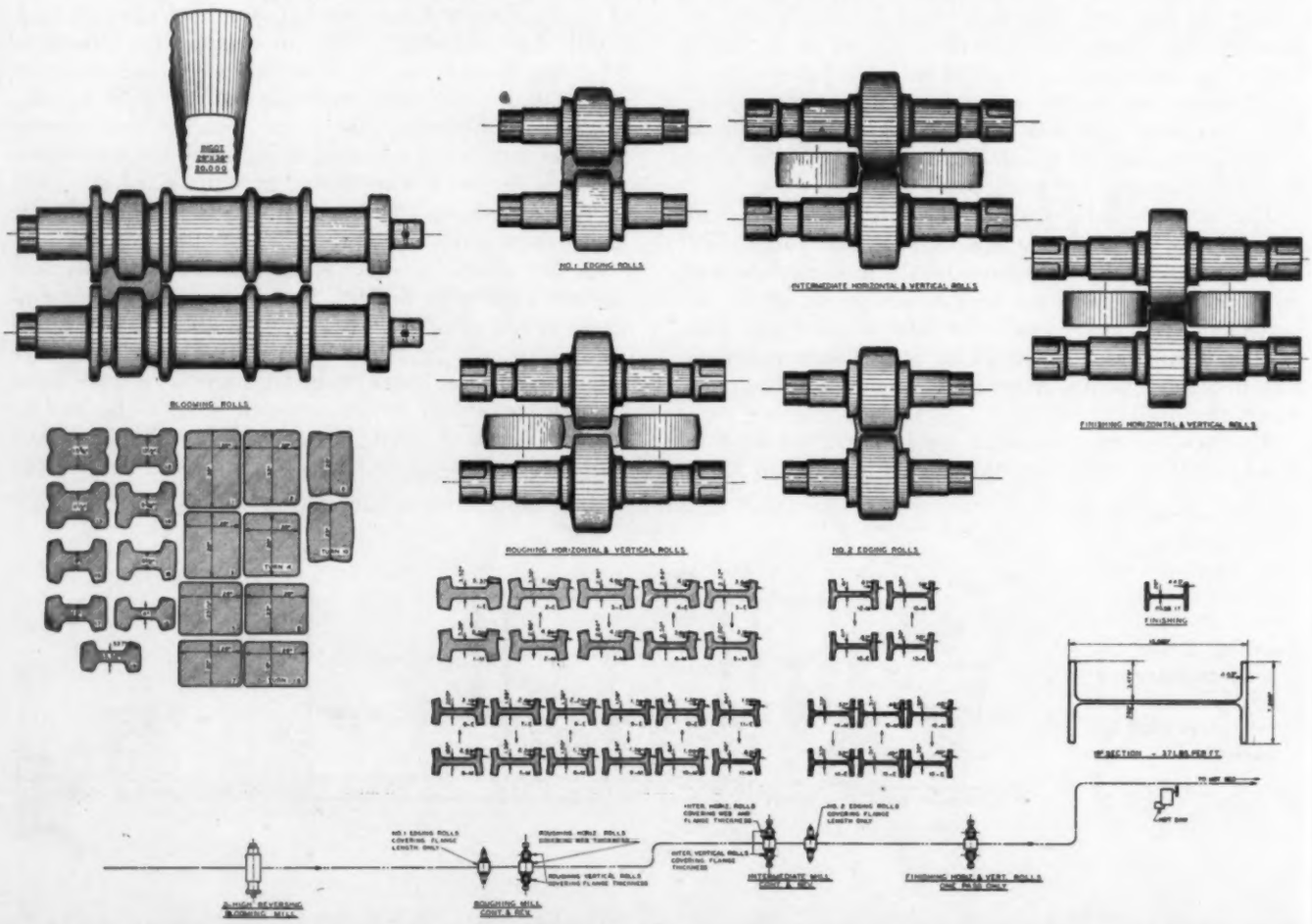
mill at once, and with each stand having a faster delivery speed than the one preceding, it is possible to have very slow, efficient roughing speeds and high finishing speeds. This arrangement provides the rolling of a large number of bars per hour or turn. One mill of this type is known to have rolled two hundred bars per hour for a period of eight hours, or a total of sixteen hundred bars.

In comparing the performance of the cross-country mill with that of a mill having the finishing stands in line and with an independent roughing mill, it is well to note that longer bars can be rolled on the latter mill than on the cross-country type. The stands of the cross-country type mill cannot be spaced too far apart or the mill will cover too much area, and require too much time for rolling.

The trend in standard structural mill design has not been directed to continuous mill operation. One type of merchant mill, however, does roll structural shapes of considerable size but of light weight sections. The advantage of this mill is in finishing thin sections in long lengths at sufficient temperature to maintain the proper physical requirements. See Drawing 6.

Beams with parallel or nearly parallel flanges are best rolled on a mill referred to as the universal beam mill. Equipped with horizontal and vertical rolls in the same stands, the mill is capable of rolling a wide range of beam sizes. Drawing 7 illustrates one such mill. It is

Drawing 7 — Universal beam mill layout, rolls and passes for medium beams.



a semi-continuous mill using a beam blank from a two-high reversing blooming mill and rolling most of the blanks directly from the ingot. The drawing shows the rolls together with profiles of the passes for a medium-sized beam.

Proper heating of blooms for structural mills is most important, since the mills have rolls of rather small diameter for the shapes rolled. The shapes of many sections are such that the rolls must be cut with deep passes and the effective diameter is further reduced. As a consequence it is necessary to have the blooms heated uniformly to a high temperature to prevent excessive roll breakage.

FURNACES

The flat-hearth type of furnace, with charging and drawing mechanism, was for many years believed to be the only type capable of heating beam blanks properly. In late years, however, modern continuous furnaces proved their efficiency for this type of work. Drawing 8 shows the two types of furnaces with beam blanks on the hearths. Note the large number of blanks in the continuous furnace as compared to the smaller number in the flat hearth type furnace.

ROLL HOUSINGS

The roll housings in use on standard structural mills are simple in design. Two types are in use for three-high stands. One has the bottom roll supported and adjusted by screws, and the middle roll supported by neck carriages with carriages between the middle and top roll and liner space between; the top and middle rolls are held down by the top screw. The other type has a fixed middle roll, while both top and bottom rolls are adjusted by screws, the top roll being supported by a spring arrangement.

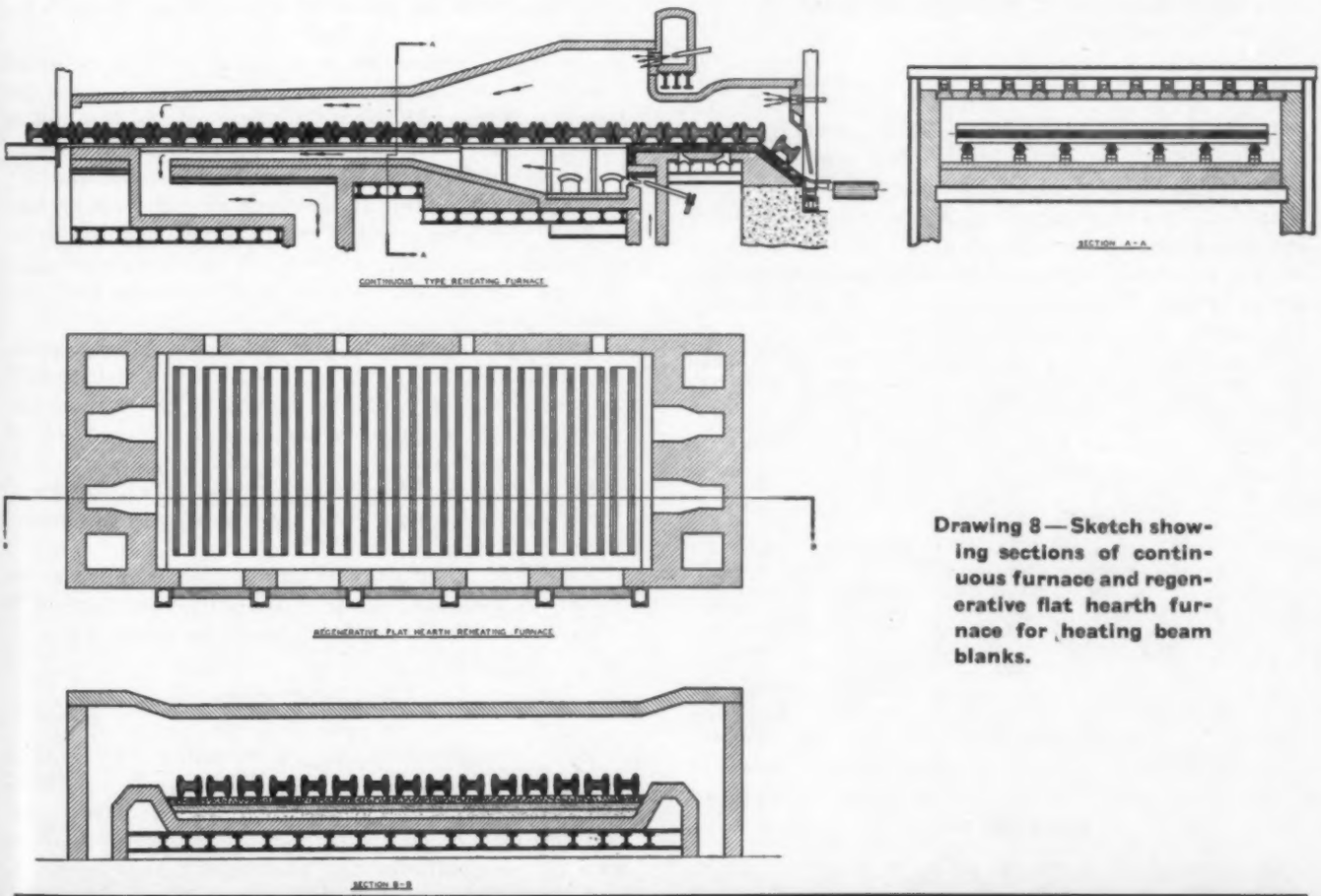
Two types of two-high finishing housings are also in use. In one the top roll is held stationary and the bottom roll is adjusted by a screw. The other has a stationary bottom roll and an adjustable top roll. Drawing 9 shows these designs in addition to a guide and rest bar arrangement.

MILL TABLES

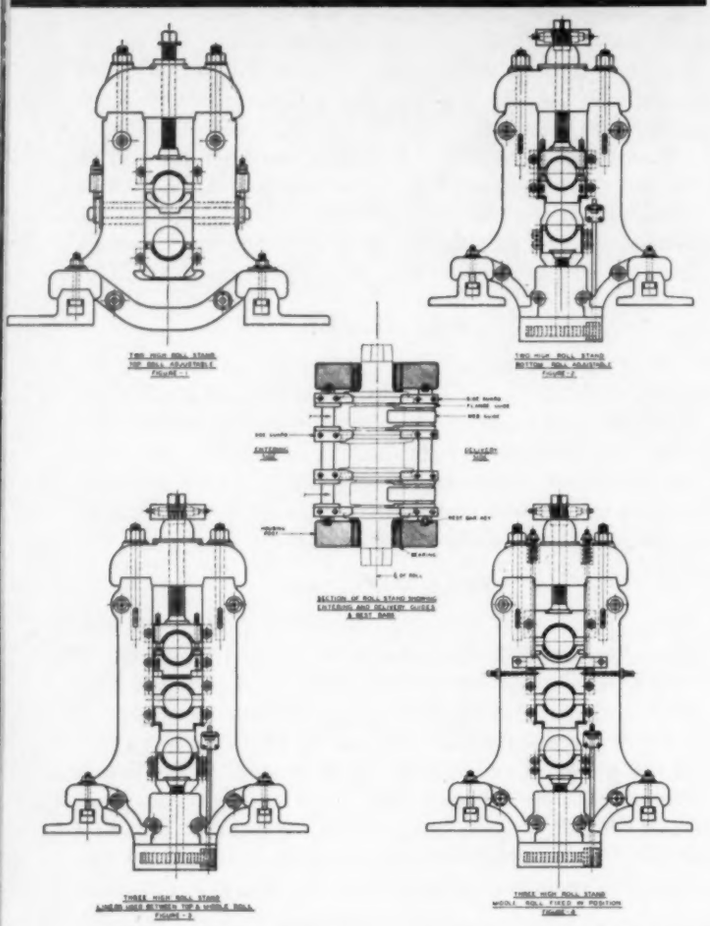
Most of the large structural mills have traveling tilting tables followed by additional traveling tables or stationary tables with traveling dogs for long lengths. Some of the smaller mills have fixed tilting tables on one side and stationary tables on the other. Cross-country mills have stationary tables with table guards to keep the bars in their proper course.

ROLL MATERIAL

Structural mill rolls fall into two general classes, either iron or steel. Sand iron, the cheapest grade, is not used to any great extent today, but various grades of alloy iron are used extensively where they have proven to be strong enough to do the work. Plain carbon steel, formerly used largely for roughing passes, is also losing out to the more efficient alloy steel types. Many hard grades of alloy steel are now being used in finishing stands. They compare very favorably in wear with the alloy iron grain type rolls and are considerably stronger



Drawing 8—Sketch showing sections of continuous furnace and regenerative flat hearth furnace for heating beam blanks.



Drawing 9 — Examples of two-high and three-high mill housing construction.

Drawing 10 shows the mold designs used for three structural finishing rolls. Figure 1 is a universal beam mill finishing roll of hard alloy steel. Note the sand-coated chilling rings placed on the wearing surfaces of the roll. These are used to chill and produce a harder surface metal to insure good wearing qualities at these points. Figure 2 is an angle finishing roll of hard alloy steel. This also has sand-coated chilling rings in the passes. Figure 3 is a top finishing roll for small channels, the roll body surface being in direct contact with the chill mold. This is an alloy iron grain type roll.

Typical analyses for rolls of the type shown in Drawing 10 are as follows:

	Figure 1	Figure 2	Figure 3
C	2.10-2.20	2.20-2.30	3.30-3.50
Mn	.40- .50	.45- .50	.40- .50
Si	.30- .35	.30- .35	1.00-1.10
S	.04 max	.04 max	.04 max
P	.04 max	.04 max	.20- .30
Cr	1.00-1.10	1.00-1.10	.90-1.00
Ni	1.50-1.75	1.50-1.75	1.00-1.25
Mo	.....	.....	.25- .30

FOREIGN MILLS

In a study of structural mills, it is interesting to examine the trend of European designs. It is evident that a number of installations in Europe have been influenced by American ideas. However, some original European designs have merit. One mill of particular interest was built in Hamborn, Germany, about 1926 (See Drawing 11). This mill rolls I-beams from 9.45 in. to 23.62 in., and H-beams from 5.50 in. to 23.62 in. with flanges up to 12 in. In addition to these beam sizes, the mill rolls channels, angles, rails, hook tie plate, railroad sleepers or ties, rounds, squares, flats and sheet bar. The mill is so arranged that two or more sections may be produced at the same time. The blooms for this mill are rolled by two 45 in. two-high reversing blooming mills and the product is rolled directly from the ingot without reheating. The tonnage of the finishing mill on favorable sections is said to be approximately 4000 tons per 24 hours. However, the outstanding feature of the mill is not the tonnage but the arrangement of stands and tables, which permits the rolling of more than one size at a time, and the fact that the mill is rarely completely down for a roll change. The rolls in the finishing mill, in which there are five stands, are all two-high, driven by two reversing motors. The number of stands driven by each motor varies according to the sections being rolled. The tables are all stationary and employ chain transfers. Necessary manipulation of billets and rounds is done by means of a simple suspended overhead manipulator.

The rolls on the mill are more than 37 in. in diameter with a body nearly 100 in. in length. These large sizes are necessitated by the fact that the mill rolls directly from the ingot, and also because the larger beams rolled require large roll diameter to prevent excessive breakage. Another feature is the fact that the two-high rolls for beams have the passes so arranged that there is no turning of the bars.

The high tonnage produced is due to the number of bars in the mill at one time. In a total of five stands, four are rolling bars simultaneously. While the mill is rolling beams in stands 1, 2, 3 and 4, stand 5 is rolling billets or sheet bar. This requires very careful spotting of the bars on the tables. However, an elaborate system of electric signals is installed, and a very efficient crew of operators makes certain that the bars are progressing through the different stands and passes without interference.

Another interesting feature of the mill is the manner in which the blooms are conveyed to the finishing mill from the blooming mill, as shown at the top of the drawing. Two traveling crane transfers are used, one of which operates over the other. These cranes are provided with finger lifts which pick up the blooms from the bloom table and convey them swiftly to the finishing mill tables.

From the standpoint of large tonnage and a great variety of product, this mill compares very favorably with some of the best of the American installations.

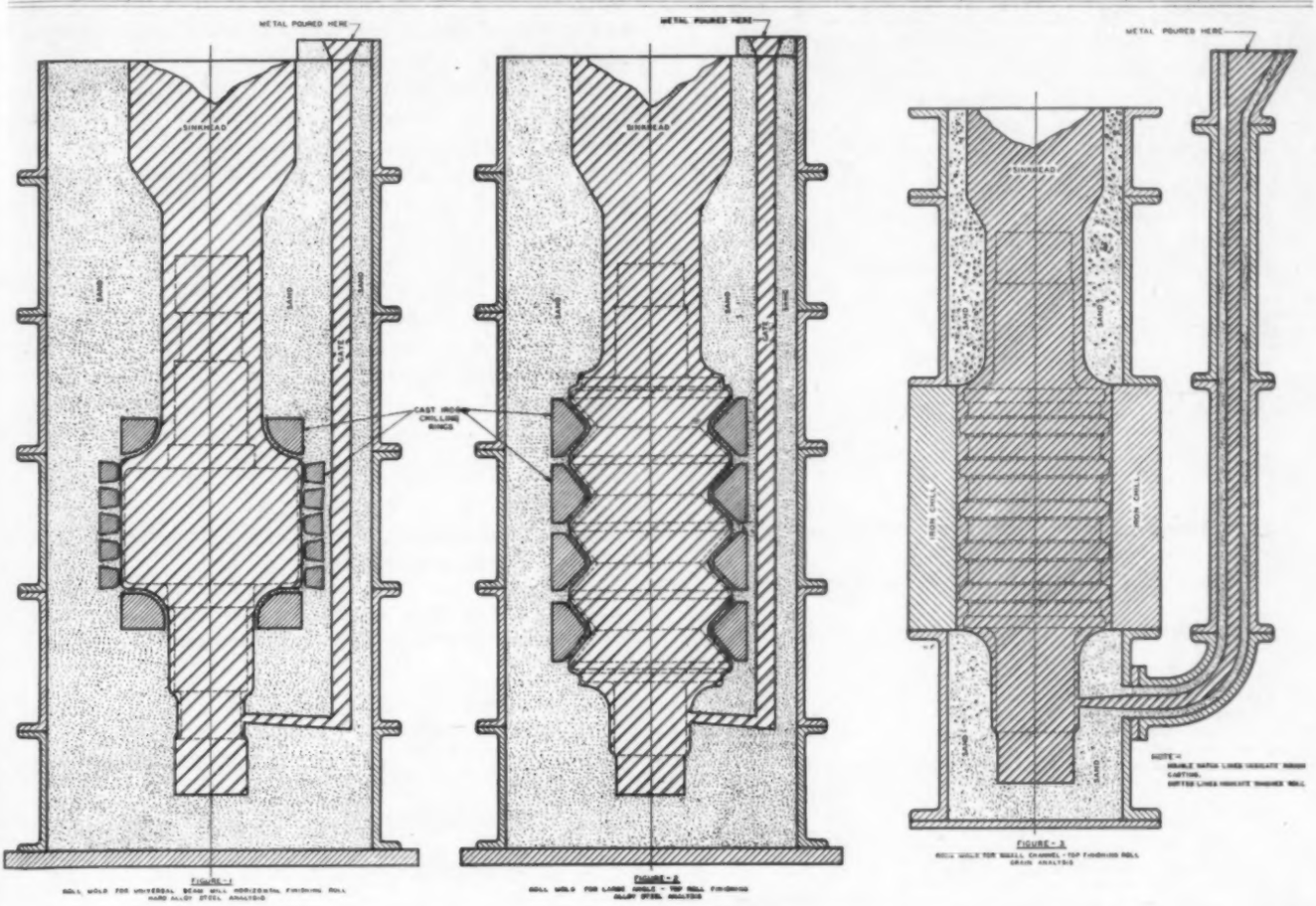
ROLL DESIGNING

Roll designing is an art rather than a science. The pioneer roll designers had very limited technical training and the roll designing they did was largely by "rule of thumb" methods. Section templets were filed pass by pass, without any preliminary drawing work, and the roll designer producing a section on the first

attempt displayed luck rather than skill. Changes made in the passes were seldom recorded, and only those who made the changes knew the details. Templets were considered the roll designer's property and were jealously guarded by him, being carried with him from job to job. Roll drawings were rarely made, and no records were kept of rolls or designs.

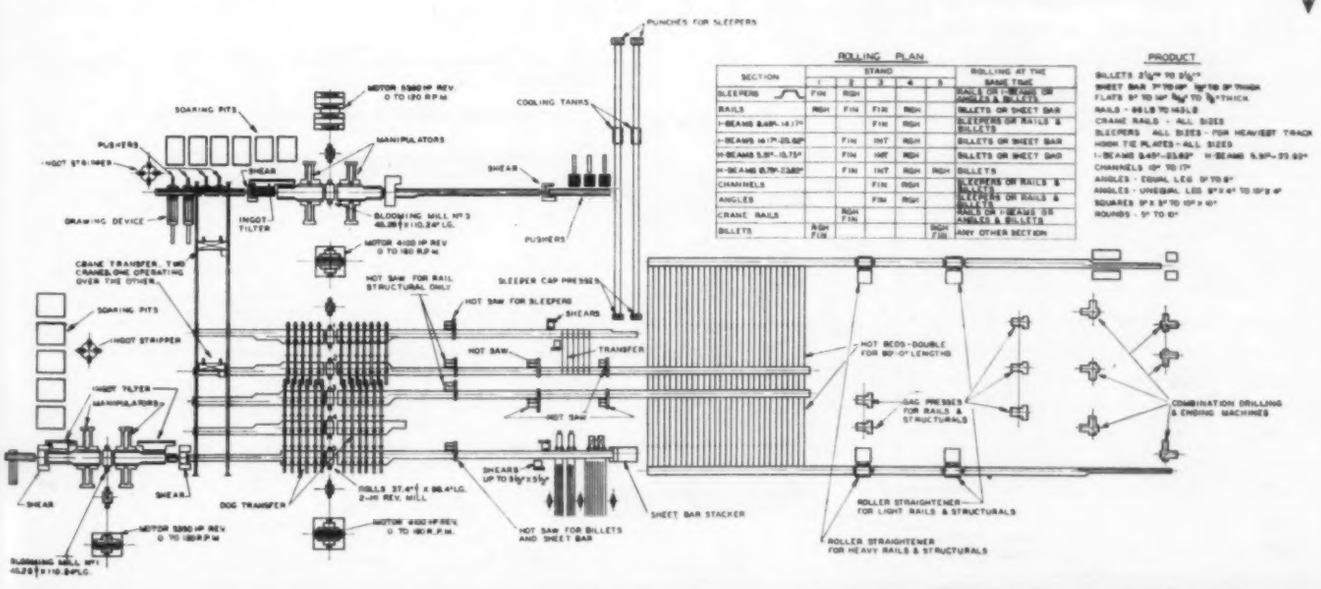
Most roll designers now have adequate technical training and experience, and have trained draftsmen and templet filers to assist them in their work. Interchange of ideas among various roll designers has broadened their viewpoint. Sections regarded as very difficult or even impossible rolling propositions in the early days of roll designing are today rolled with comparative ease.

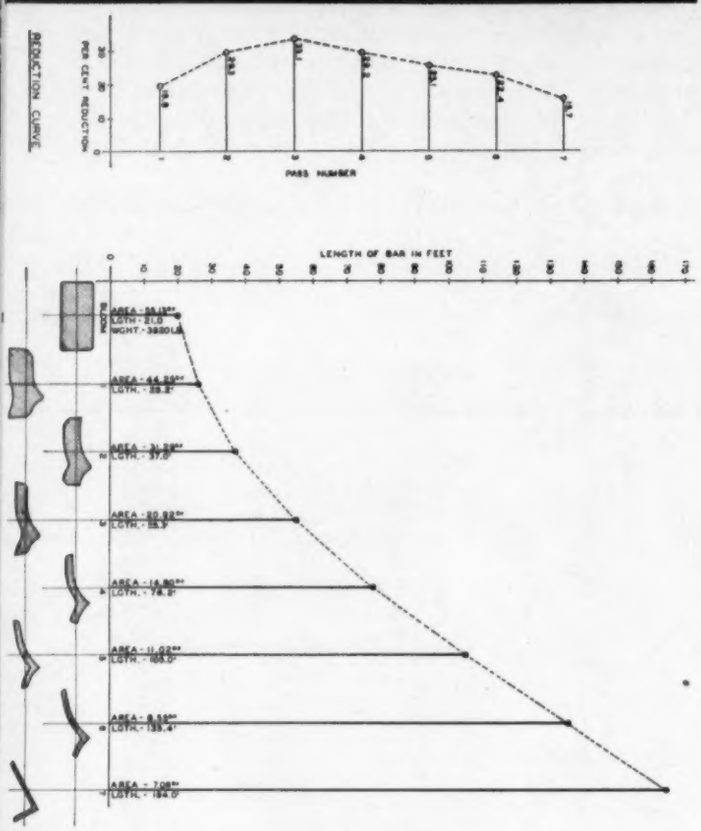
Books of practical value in roll designing are few in



Drawing 10 — Examples of molds for structural mill rolls.

Drawing 11 — Layout of German structural mill which offers high tonnage and great flexibility.





number. The roll designer must be a student of actual performance rather than theory, and must know by experience the rolling characteristics of every section which he is called upon to design.

A thorough knowledge not only of roll designing and roll turning but also of mill rolling practice is required, and if the designer lacks any of these qualifications he will be at a great disadvantage.

Open hearth, bessemer and especially alloy steels have different rolling characteristics, and the difference in the flow of metal in these steels must be given careful consideration in designing passes.

The shape roll designer must be gifted with sufficient imagination to visualize the shape each pass will take in reduction from the ingot to the finished size.

Knowledge of all available roll materials is required, as the use of the proper material may determine the success or failure of the design.

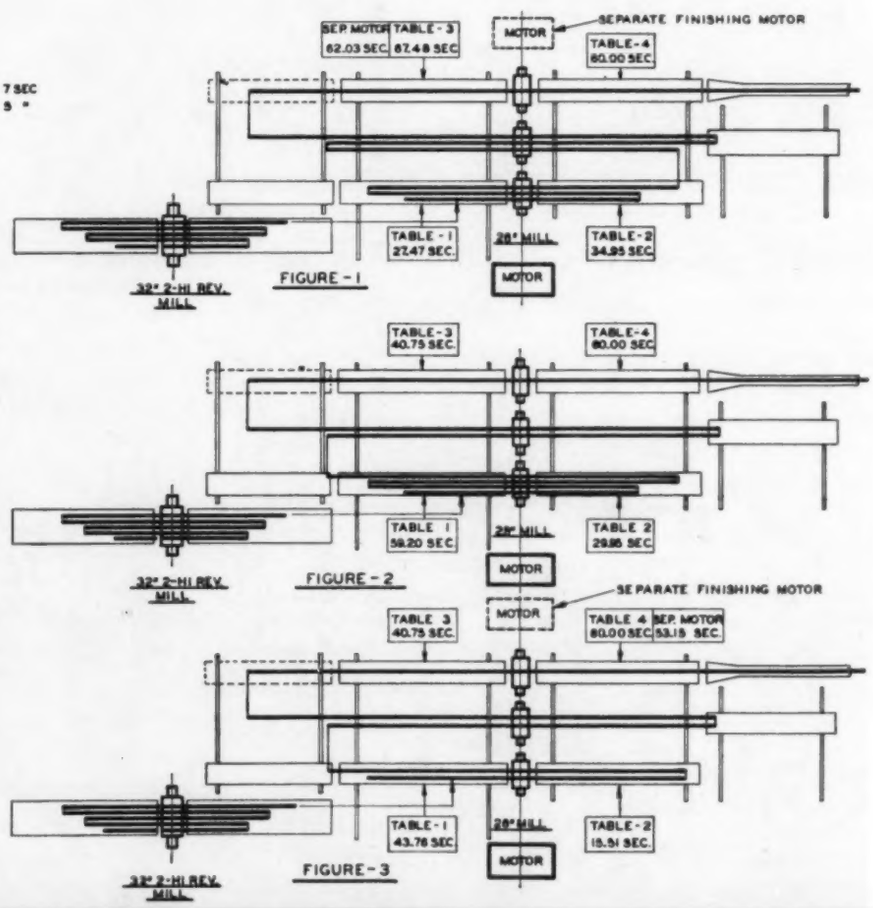
In rolling large shapes, considerable difficulty is experienced in getting the metal to flow in the desired direction. The tendency is for the material to elongate and spread in rolling, and where there are long flanges to fill, careful designing is needed to accomplish the desired result.

Drawing 12 — Reduction and elongation curves for 9 in. x 4 in. x 5/8 in. angles. (left)

Drawing 12A — Time studies of pass arrangements in a mill rolling 4 in. x 4 in. x 3/8 in. angles. (below)

BLOOM AREA - 80[sq in] TOTAL WEIGHT - 1880 LB. 7.21' LG.
IN FIG. 3 THERE ARE ONLY 10 PASSES INSTEAD OF 12
AS IN FIGS. 1 & 2, HENCE PASS Nº 2 BECOMES THE
BLOOM WITH SAME WEIGHT & LENGTH.
TIME INTERVAL BETWEEN PASSES IN BREAKDOWN MILL IS 7 SEC
" " " " " FINISHING " " 5 "

PASS	AREA	LGTH	R.P.M.	F.P.M.	TIME IN SEC.	
	68.0	8.74'	30	251	2.1	1
	58.5	10.18'	37.5	313	1.9	2
	48.8	12.17'	45	376	1.9	3
	40.0	14.86'	52.5	438	2.0	4
	29.5	20.14'	60	501	2.4	5
	26.07	22.8'	100	732	1.9	6
	18.10	31.1'	100	732	2.54	7
	12.41	47.9'	100	732	3.93	8
	7.39	80.4'	100	732	6.58	9
	4.79	124.0'	100	732	10.15'	10
	3.40	174.7'	100	732	14.35	11
	2.97	200.0'	100 150	732 1098	16.40 10.95	12



DRAFTING ON STRUCTURAL SHAPES

The draft which may be taken on standard structural shapes varies according to roll size, mill layout, analysis and temperature of the steel rolled. It must also be adapted to the thickness and the shape of the sections to be produced.

In general, proportionate elongations are required for the thick and thin portions of the sections, and these can be secured only by proportionate percentages of reduction over all the planes of the bar.

Drafts are usually measured in inches and fractions of inches, and while the draft in inches is increased from the finishing toward the roughing, the percentage of reduction in most cases does not increase, and in many cases decreases.

The elongation in a series of passes, if charted, follows a parabolic curve, while the percentage of reduction would not follow the same type of curve. As an example, Drawing 12 shows the passes for a 9 in. x 4 in. angle, and in addition, the elongation of each pass and the percentage of reduction in graph form. Note that the elongations follow a parabolic curve, while the percentage reduction for the same passes, as shown in the left hand side of the graph, are dissimilar.

This serves to illustrate the fact that structural shape passes are not usually designed on the basis of percentages of reduction, but are developed from experience in rolling these shapes. The designers take into consideration roll diameters, standard billet or slab sizes, mill power, spreading characteristics, and a number of other practical considerations. Some of these factors are not favorable to progressive percentage reductions.

TIME STUDY OF PASS ARRANGEMENT

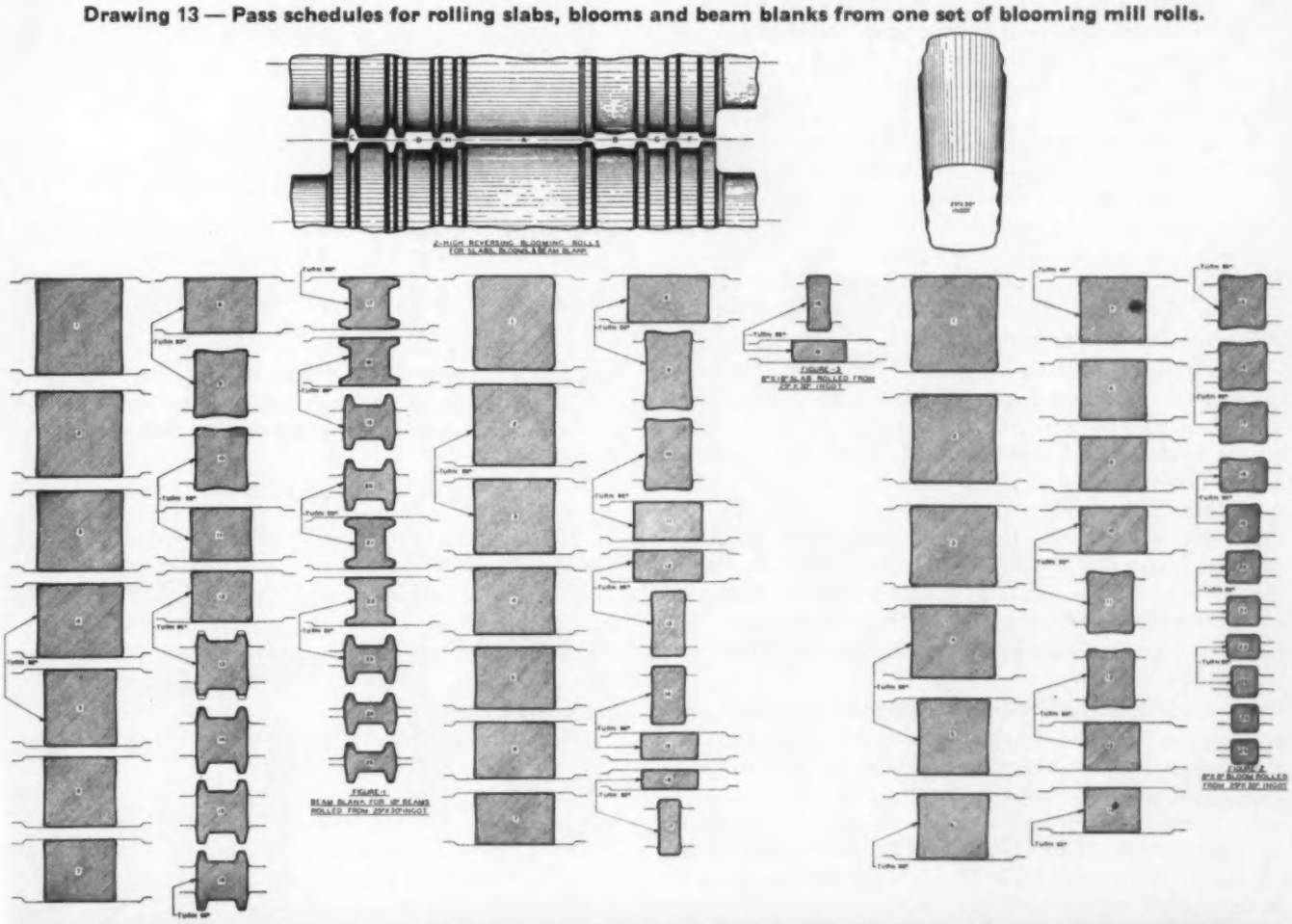
In designing passes for structural mills, and particularly for mills where it is possible to transfer bars from stand to stand on either side of the mill, a time study of the possible roll and pass arrangements is required in order to determine the design which will give the best tonnage.

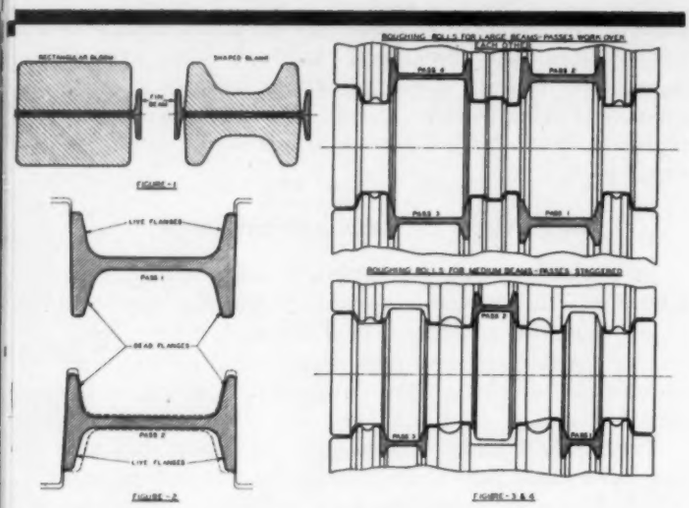
Figures 1, 2, and 3 in Drawing 12-A show diagrammatically three pass arrangements for a structural mill which has a separate two-high reversing breakdown mill that is followed by a three-stand finishing mill. The first two stands of the finishing mill are three-high, and the last stand, two-high; all three stands are driven by one motor. A traveling tilting table is installed on each side of the mill.

A 4 in. x 4 in. x $\frac{3}{8}$ in. angle, which had been rolled to a 200 foot finished length through seven shape passes, was selected as a section which would be small enough to permit the various pass groupings shown in the figures.

The breakdown mill feeds directly onto table No. 1

Drawing 13 — Pass schedules for rolling slabs, blooms and beam blanks from one set of blooming mill rolls.





Drawing 14 — Sketch showing methods of reduction in rolling beams.

which then moves over in line with stand No. 1 of the finishing mill. The speed of the breakdown mill varies from 30 to 60 rpm, while the speed of the finishing mill is a constant 100 rpm. In Figure 1, there are five passes in the breakdown mill, which require 40 seconds to roll. In the finishing mill there are three passes each in the first and second stands and one pass in the last stand. To handle one bar and be ready for the next bar, table No. 1 is kept busy 27.47 seconds. Table No. 2 is kept busy 34.95 seconds in handling and transferring the bar to the second stand and returning to position. Table No. 3 is kept busy 67.48 seconds, handling and transferring the bar to the finishing stand and returning into place for the second bar. Table No. 4 is kept busy 60 seconds in handling and receiving the bar from the finishing pass and returning to stand No. 2. Table No. 3 is the limiting factor. With this arrangement it is possible to roll 53 blooms per hour. A separate motor to drive the finishing stand at 150 rpm would cut the time down for table No. 3 to 62.03 seconds and permit rolling 58 blooms per hour.

In Figure 2 another arrangement of passes is shown. In this scheme there are five passes in the breakdown mill, four passes in the first finishing mill stand, two passes in the second, and one in the third. The limiting factor in the arrangement is table No. 4, which works two passes in stand No. 2 and then moves over to stand No. 3 to receive the bar. This table requires 60 seconds time, and 60 blooms can be rolled per hour. There would be no gain in tonnage with a separate motor for the finishing stand in this arrangement, as table No. 1 takes almost the same amount of time to handle the bar.

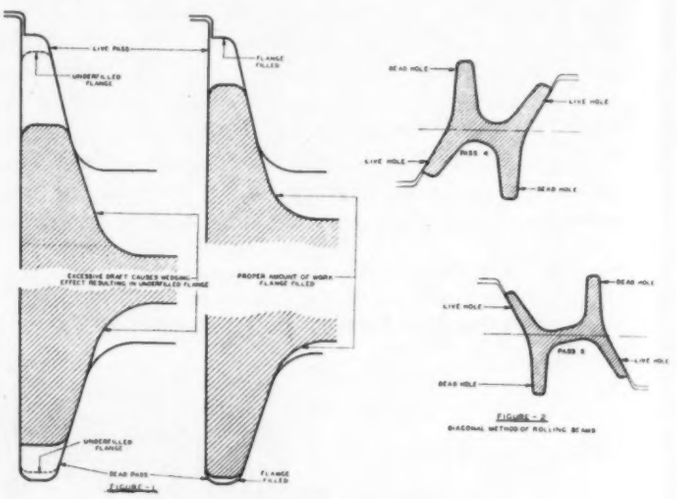
Figure 3 illustrates another arrangement. There are five passes in the two-high breakdown mill, the last two being the first two shape passes. In the finishing mill there are only five passes, divided two, two, and one. Owing to longer lengths in the two-high breakdown mill, it requires 44 seconds to roll the bar in that mill. In the finishing mill, table No. 4 is the limiting factor, requiring 60 seconds per bar, or 60 blooms per hour. Driving the finishing stand with a separate motor running at 150 rpm would cut the time for table No. 4 to 53.15 seconds and permit rolling 68 blooms per hour.

These figures are for 100 per cent performance, eliminating all delays, and could rarely be attained in actual practice. For the benefit of those who wish to examine this procedure in detail, the necessary data are given on the drawing.

BLANKS AND BLOOMS

In the rolling of beams and channels, a shaped blank or a rectangular bloom or slab is produced in the blooming mill for further reduction and shaping in the finishing mill.

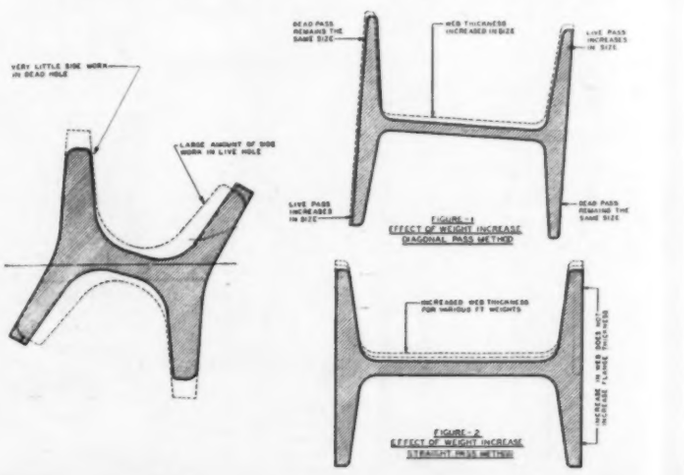
Drawing 13 shows a blooming mill roll design suited to rolling either shaped blanks or rectangular blooms, as well as slabs and billets. The passes are illustrated for blanks, blooms, and slabs.



Drawing 15 — Sketches showing methods of flange reduction and diagonal rolling of beams. (above)

Drawing 16 — Tilting the "live" flange results in very little side work in the "dead" hole. (below left)

Drawing 17 — The straight pass method of rolling is advantageous in that the web may be rolled heavier without increasing flange thickness. (below right)



In the rolling of the beam blank, the ingot is first rolled on all sides in the bullhead A to change the ingot skin structure to a rolled structure. The ingot is then roughed to a size necessary for entering the edging pass B, where it is rolled to the size necessary for entering the beam blank pass C. After several passes an overfill begins to appear at the roll parting, necessitating the return of the piece to the bullhead, where it is turned 90 degrees and the overfill rolled off. The piece is then returned to the beam blank pass and finished to the required size. These passes are illustrated in Figure 1.

Rectangular blooms and slabs are broken down in the bullhead A and worked in the edging passes B, D, F, G and H to bloom or slab as required. See Figures 2 and 3.

In rolling a beam or channel from a shaped blank, there is considerably less web elongation than there is when rolling the sections from a rectangular bloom.

Drawing 14, Figure 1 shows a rectangular bloom drawn over the beam for which it is used, and also a shaped blank over a similar beam. It is readily seen that the shaped blank will give a more uniform and proportionate reduction between web and flange than the rectangular bloom.

The advantages of a shaped blank are obvious but they require special blooming rolls and the shaped blank requires more blooming mill passes for the same size beam than does the rectangular bloom. However, the shaped blank requires less passes in the finishing mill. From the foregoing it is plainly seen that skillful distribution of the draft for beams or channels is required in order to obtain satisfactory designs.

BEAMS

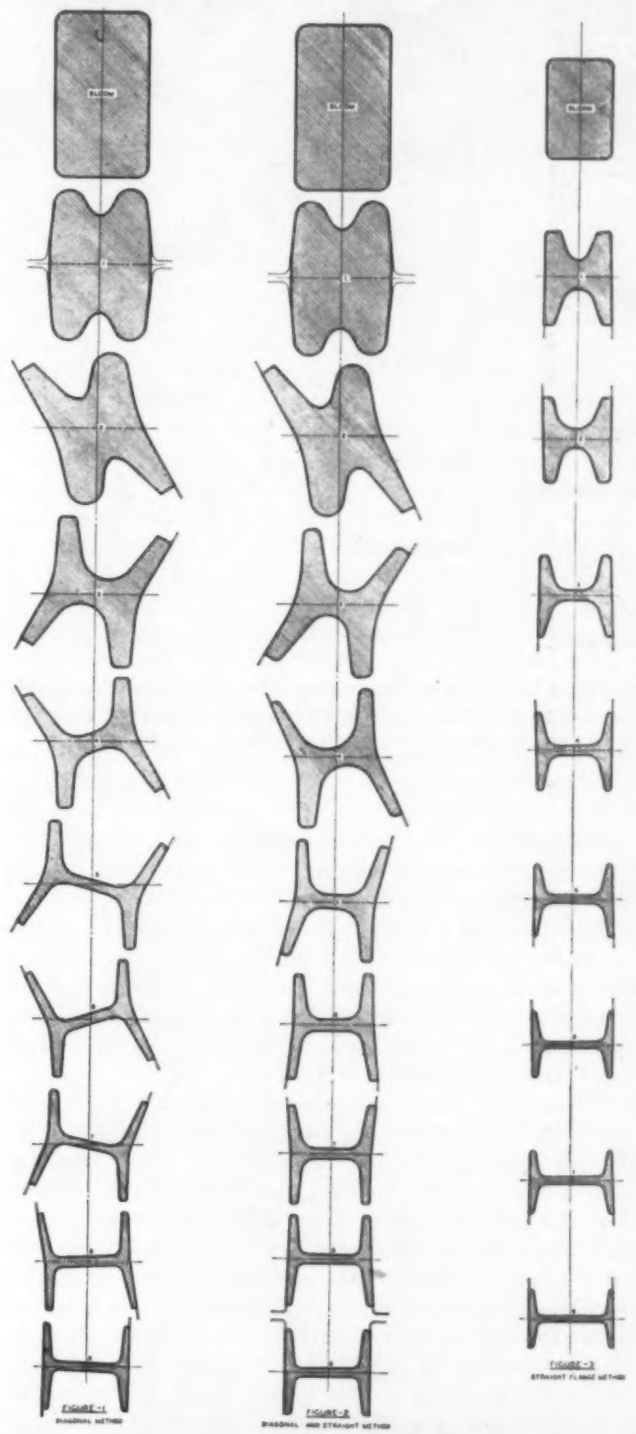
The roll design most used for beams is one in which the web of the beam is parallel to the roll axis and the flanges are at an angle of nearly 90 degrees to the axis. In cases where two rolls work together on the flanges, the flanges are referred to as "live," and where only one roll works on the flanges, the pass is referred to as "dead." Two rolls operate on the web at all times. In Drawing 14, Figure 2, two beam passes are shown in which "live" and "dead" flanges are alternated. This method is referred to as the straight flange design.

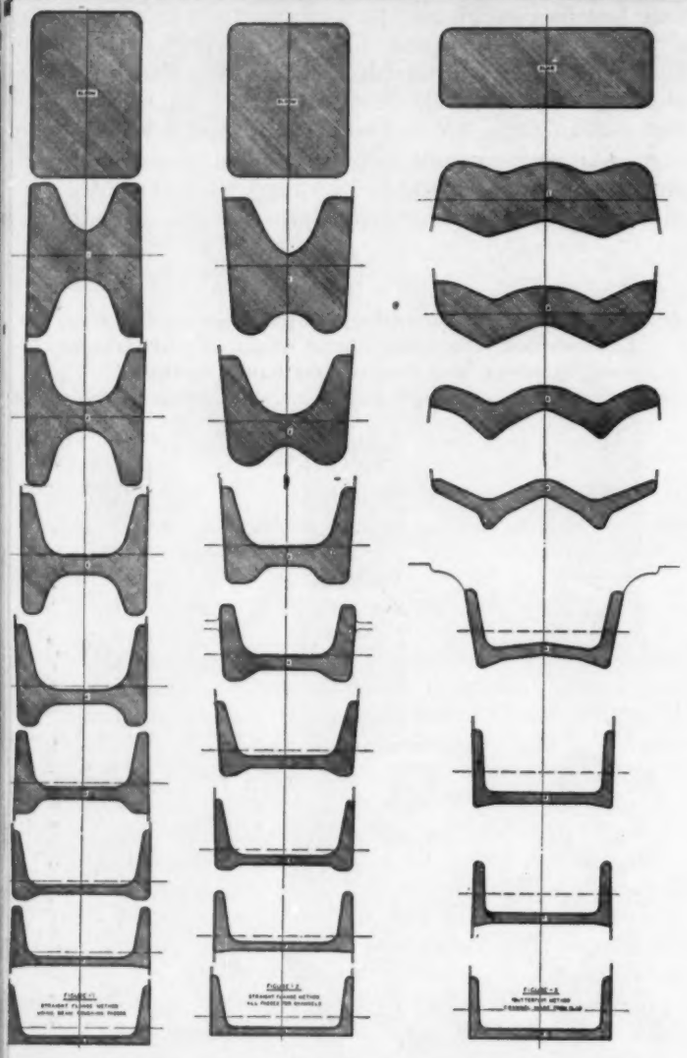
Figure 3, Drawing 14, shows a set of three-high roughing rolls with four passes. Space in the roll is limited, and because four passes are necessary, they are placed as shown, pass 2 over pass 1, and pass 4 over pass 3. In a design of this kind, the distribution of the flange draft is poor. The flanges in the middle roll, being over each other, must be practically the same size, and are sometimes smaller in area than the "dead" flanges they enter. Figure 4 on the same drawing illustrates a more efficient design. In this layout there are three passes in the roll and, as the beam is a smaller one, there is room to stagger the passes, thus permitting a better distribution of draft.

Heavy reduction in side work on "live" beam passes without a corresponding reduction in the so-called "dead" holes will almost invariably result in the "live" flange being underfilled. The wedge principle is illustrated by the action of flange side work. A thick blunt wedge cannot be driven as readily as a thin sharp one (See Drawing 15, Figure 1).

Heavy side work on the "live" or "dead" flanges of a beam corresponds to the blunt wedge. The flange will elongate and underfill, stretching out with the web rather than filling up. In cases of this kind it is necessary to use considerable side work in the "dead" holes to balance the work and hold the flange up in the "live" hole to prevent it from rolling down. The elongation of

Drawing 18 — Passes for rolling a 4 in. beam by the diagonal method, the combination diagonal and straight flange method, and the straight flange method.





Drawing 19 — Passes for rolling channels by the straight flange method from beam roughing passes or from channel passes, and by the butterfly method.

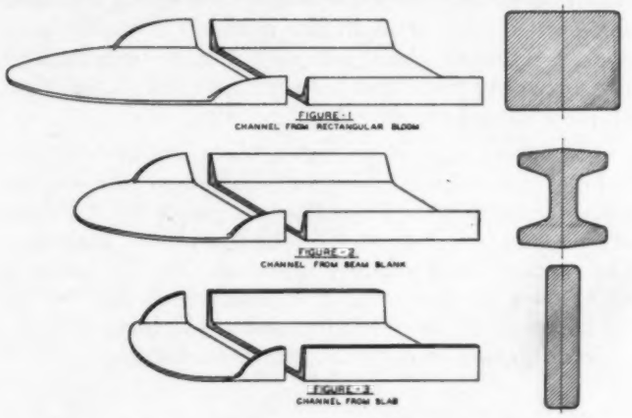
the "live flange and web draws the "dead" flange and thins it sufficiently to fill the "dead" hole, even though it is rather thick to start with.

The diagonal pass design is one in which the passes are tilted at an angle with the axis of the roll. These passes are resorted to when the straight flange method will not give the desired results. This design is especially good for beams with long thin flanges and with a small side taper (Drawing 15, Figure 2).

Tilting the "live" flanges permits rather heavy flange drafts without causing the flange to run short. The further the flange is tilted, the more the draft may be. This is true because the flange is tilted to such a degree that it causes a direct rolling action between the two rolls; thus the flange is not drawn to the degree that takes place in the straight method. In the use of this method, however, it is not possible to have any appreciable amount of side work in the "dead" holes. Because of the small inside taper of the flanges, the wedging effect of side work in the "dead" holes is great, with very little pushing effect from the work on the live flanges (See Drawing 16).

The disadvantage of the design arises from the fact that raising the rolls to get thicker webs will result in the "live" flanges becoming thicker while the "dead" flanges remain the same size (Drawing 17, Figure 1). The web also is increased in depth, and thus only one size and foot weight can be made accurately with this design. Figure 2 shows a straight flange beam in which raising the web does not change the flange thickness or increase the depth of the beam.

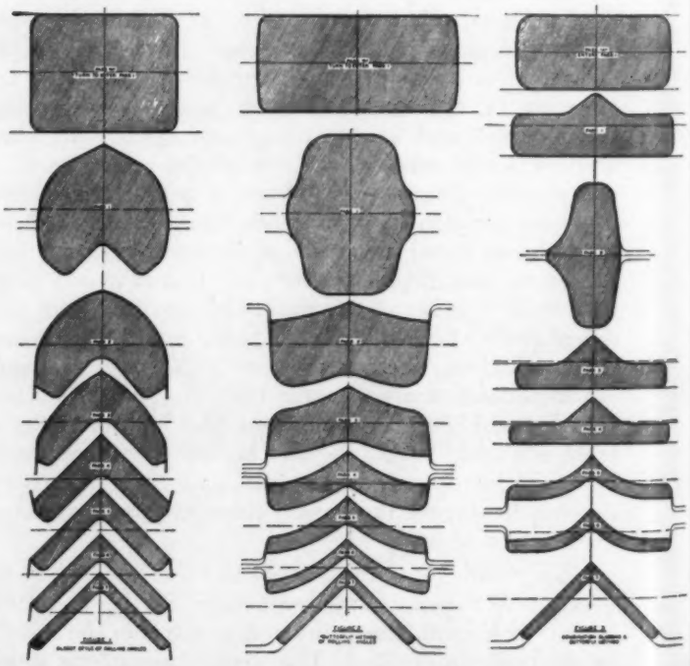
Another design used to advantage for long thin flanges, and one in which more than one foot weight may be produced, has diagonal roughing passes and straight finishing passes. The flanges in the last passes of the scheme, with the exception of the finishing pass, are bent out to a small degree so that a fair amount of side work may be used. In this design the diagonal roughing passes are not raised for increased foot weights, although the straight finishing passes are, there being sufficient web reduction between the last diagonal pass

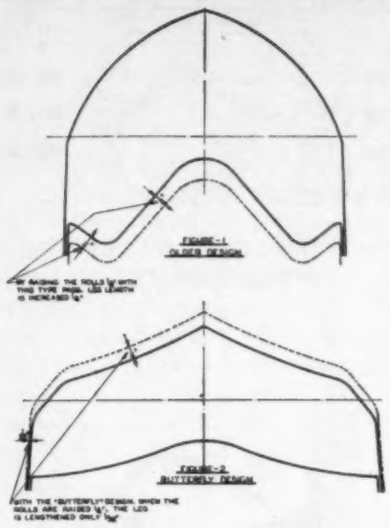


Drawing 20 — Sketch showing proportionate crop loss on channels rolled by three different methods.

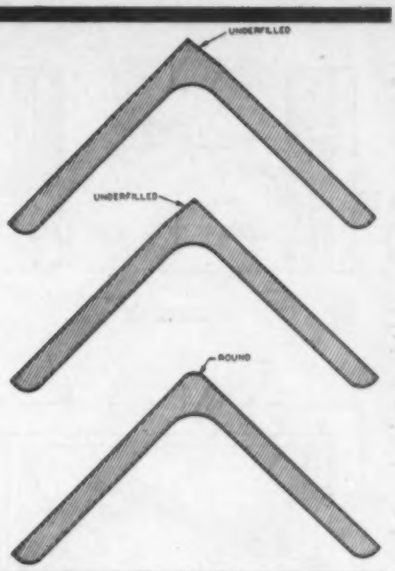
▲

Drawing 21 — Passes for rolling angles by three different methods.





Drawing 22 — Sketch showing advantages of the butterfly method in rolling 4 in. x 4 in. angles.



Drawing 23 — Sketch showing some defects often encountered in rolling angles.

and the first straight pass for the increased foot weights (Drawing 18, Figure 2).

Drawing 18 shows the three methods of rolling beams. Figure 1 illustrates the diagonal method, Figure 2, the combination diagonal and straight flange method, and Figure 3, the straight flange system.

The diagonal passes are sometimes used for small standard beams when it is desired to use a relatively small billet or bloom, for one of the features of the diagonal scheme is that it requires less billet or bloom area than the comparable straight method.

CHANNELS

There are a number of pass designs used for rolling channels, and the particular design used depends to a certain extent upon the characteristics of the section, as well as upon the mill layout. In one of the designs frequently used, the first roughing passes are the same for beams and channels of the same size. When producing channels the bottom flanges are rolled off in the later passes (Drawing 19, Figure 1). Still another approach is to bend a slab into a channel. This latter scheme is called the butterfly method (Figure 3).

The first design shown in Drawing 19, which uses beam roughing passes, has no particular merit except in lower roll costs for the roughing passes and the fact that spreading the rolls apart for heavier weights does not increase materially the flange thickness. This makes it relatively easy to roll a number of foot weights in the same passes.

The second design, as shown in Figure 2, has the advantage of preserving the channel shape throughout, as contrasted with the first method in which a beam shape is first built up and then rolled down into a channel.

The butterfly method, Figure 3, in which the early passes have the flanges sloped at a satisfactory angle, permits heavy reductions up until the last few passes, thus maintaining the heat in the flange and allowing a larger sized slab to be used.

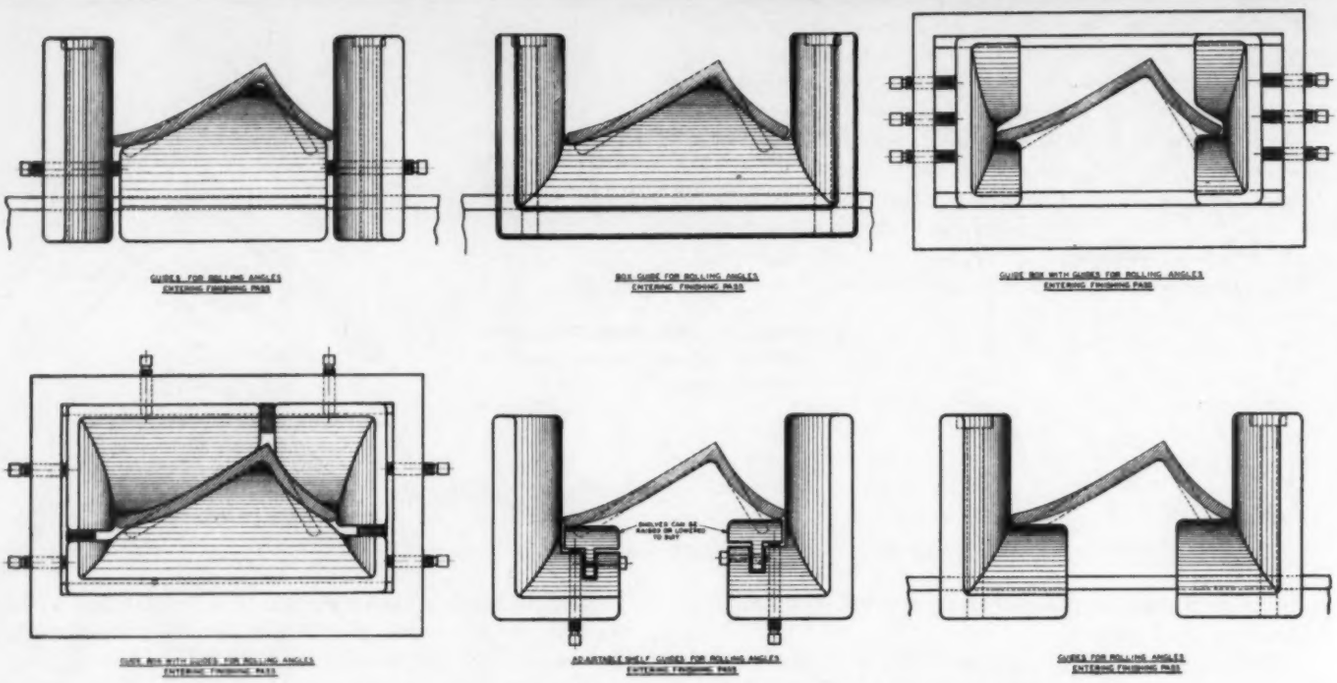
The butterfly method is best for the type of channel which has very little taper on the inside of the flanges. This slight taper makes it impractical to have any great amount of side work on the flanges when the flanges are set at right angles with the pitch line. The laying-back of the flanges in the roughing passes of the butterfly system makes it possible to do the necessary heavy drafting on flange and web while the passes are nearly parallel to the pitch line. When the flanges are bent up, heavy side work is not required on the flanges in order to finish the section to size.

Ship and car-building channels are sections with flanges of little inside taper, no great variation in web thickness for the various foot weights, and little variation between flange and web thickness. These features make these sections ideal for the butterfly design. Several advantages are apparent in rolling these channels by this method. One is better yield. In a study covering a period of years, it has been found that there are less rejections with butterfly-shaped channels for scrappy and underfilled flanges than for comparable sections rolled with the flanges straight. This is due not only to the shape of the section, but also to the method by which the flanges are rolled in the earlier passes, instead of being stretched as they are in the straight method. Another advantage to which very little attention has been given is the fact that the uniformity of drafting between the flange and web in the butterfly system is such that the section is uniform almost to the very ends of the bars. This means that there is less waste at the hot saws, cold saws, or shears in cropping back to obtain a perfect section. Actually, it has been found in practice that there is approximately two feet per bar less crop required with ship and car-truck channels than with comparable channels rolled by the straight flange method, which means a considerable increase in yield.

Drawing 20, Figures 1, 2 and 3, show the hot saw crop required for three different bloom shapes.

ANGLES

There are several methods that can be used in the rolling of angles, both with even and uneven legs. The oldest design starts with a square and keeps the legs



Drawing 24 — Various arrangements of entering guides for finishing stand rolling angles.

at a 90 degree angle throughout, as shown on Figure 1, Drawing 21. This design is not used to any extent today because the length of the legs is very irregular, owing to the manner in which the roll openings are fixed in the roll. Raising the rolls for increased leg thicknesses results in very uneven leg lengths, making it difficult to get the ends of the legs square, as shown in the drawing of the finishing pass.

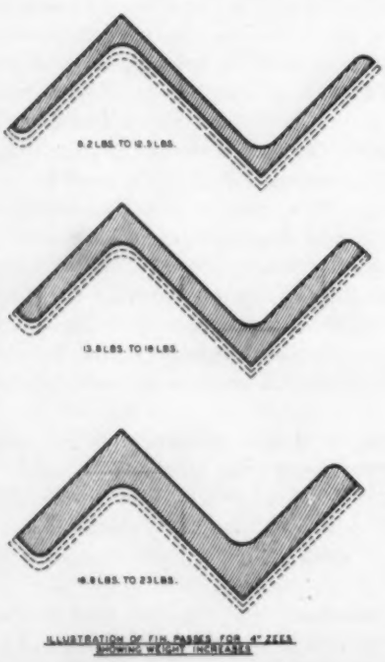
The most commonly used design is the butterfly system, as shown in Drawing 21, Figure 2. This design takes a slab into the first shape pass, the passes being sufficiently flared to enable the use of alternate up-and-down collars. This permits the legs to rest firmly against the ends of the passes, squaring them to eliminate uneven legs. In this design it is possible to make two or more leg thicknesses in the passes without exceeding the leg tolerance.

On mills of the cross-country or those of the semi-continuous types, a design similar to the one shown in Figure 3, Drawing 21, is often used. In this design the first passes are of the flat slab type, with a triangular apex turned in the top roll. The first passes are common to all angle sizes rolled. Edging passes regulate leg length. Of the three finishing passes, two are grooved for the particular size being rolled. The finishing pass itself bends the flared legs up to 90 degrees, and this pass may also be used for more than one size of angle.

The slab passes have no collars to confine the bars, and some very careful guide-setting is required to keep the bars running true in the proper roll space. The principal feature of this scheme is the number of sizes which may be rolled in the roughing passes without a roll change.

The advantages of a butterfly design of rolling angles over the old system are best illustrated by Figures 1 and 2 in Drawing 22. With this old style angle design, raising this particular pass ¼ in. to produce a heavier leg thickness lengthens the legs ¼ in. On the corresponding pass in the more modern butterfly design raising the pass ¼ in. increases the legs only $\frac{1}{32}$ in. This indicates that considerable variation in angle leg thicknesses may be rolled in the butterfly passes without lengthening the legs appreciably.

In the rolling of angles, two items offer most difficulty. One is an underfilled condition of the apex, of which there are two different manifestations. The first is a rounding of the apex caused by insufficient metal at this point (See Drawing 23). The second is a chamfering



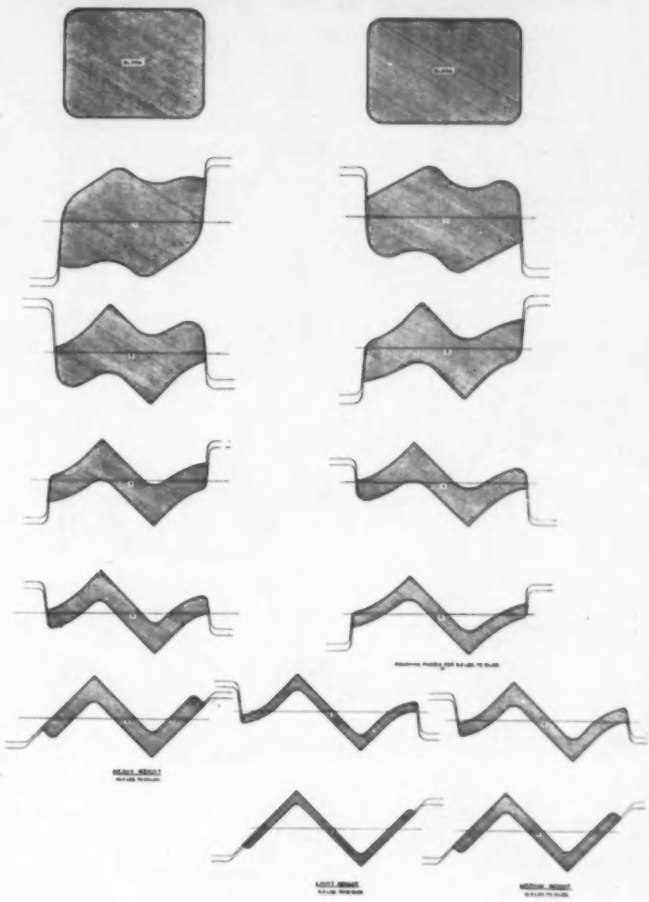
Drawing 25 — Showing finishing passes for zee bars.

off at one side or the other of the apex. In the latter case, there is sufficient metal provided for the apex, but due to the leader apex not being in line with the finishing pass apex, an undesirable condition develops. The same condition also develops from an unequal thickness of leg in the leader pass. The other problem is leg tolerance on the heavier foot weights of a given section. The remedy for this is more passes of the correct leg length, particularly in the two passes preceding the finishing. Usually the butterfly system does not require light and heavy passes farther back in the roughing.

Drawing 24 shows a number of finishing entering-guide designs for angles. These guides are in use on most structural mills, but not more than two of these designs are in use in any one plant. The various methods used show that much thought has been given to the accurate alignment necessary for the bar entering the finishing pass.

ZEE BARS

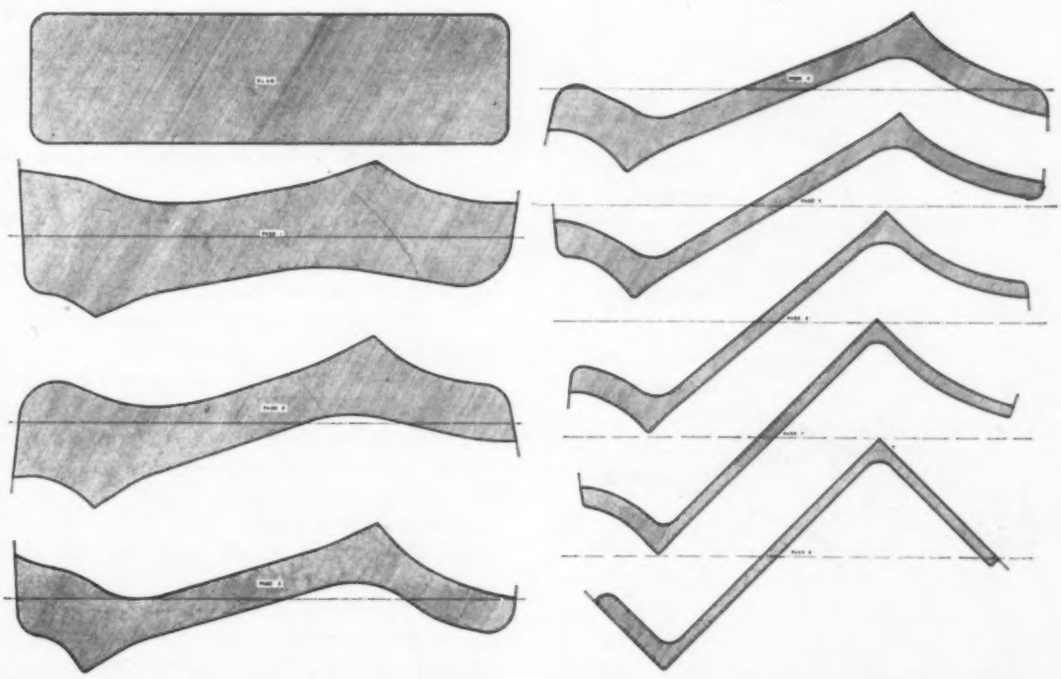
The remarks covering angles are equally applicable to the legs of zee bars. However, on the zee bar, the center web must be considered. Tolerances used on zee bars will not permit much change in web height, and for this reason, standard zee bars usually require three finishing passes for each nominal zee bar size. Note on Drawing 25 that raising the rolls for greater foot weights lengthens not only the legs, but also the center part of the bar. The drawing represents the three finishing passes for a 4 in. standard zee bar. The top pass makes the three weights 8.2 lb to 12.5 lb; the middle pass, weights from 13.8 lb to 18 lb; the bottom one, from 18.9 lb to 23 lb. Drawing 26 illustrates the passes from the bloom to the finishing of this 4 in. zee bar. There are two lines of passes, the heaviest weights, 18.9 lb to 23 lb, being made from one line, and the 13.8

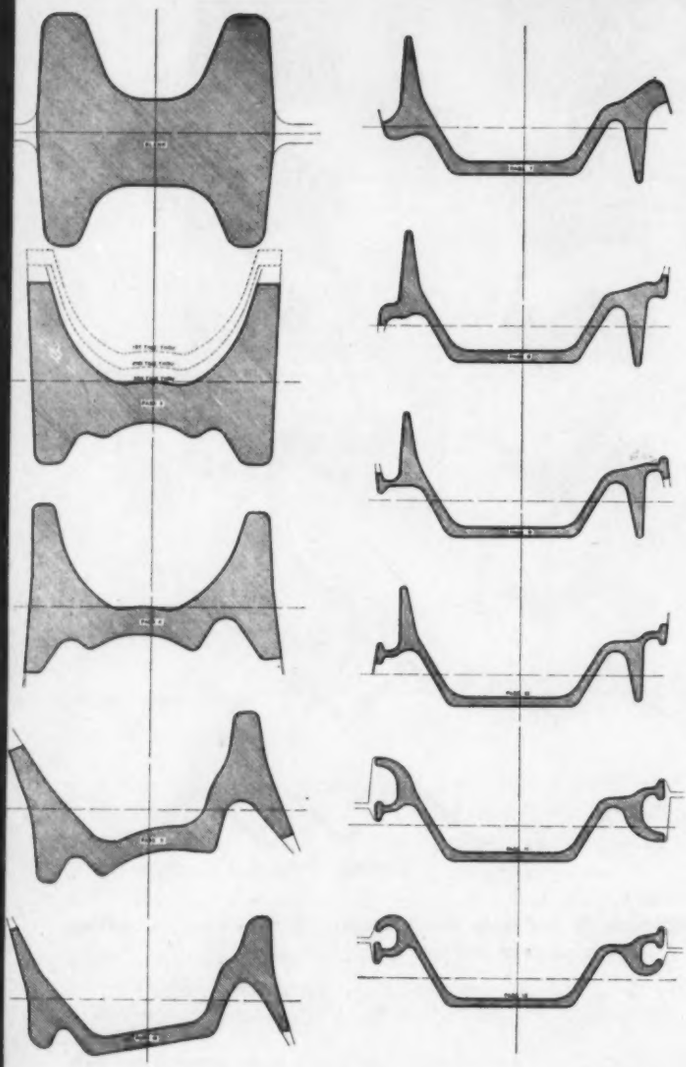


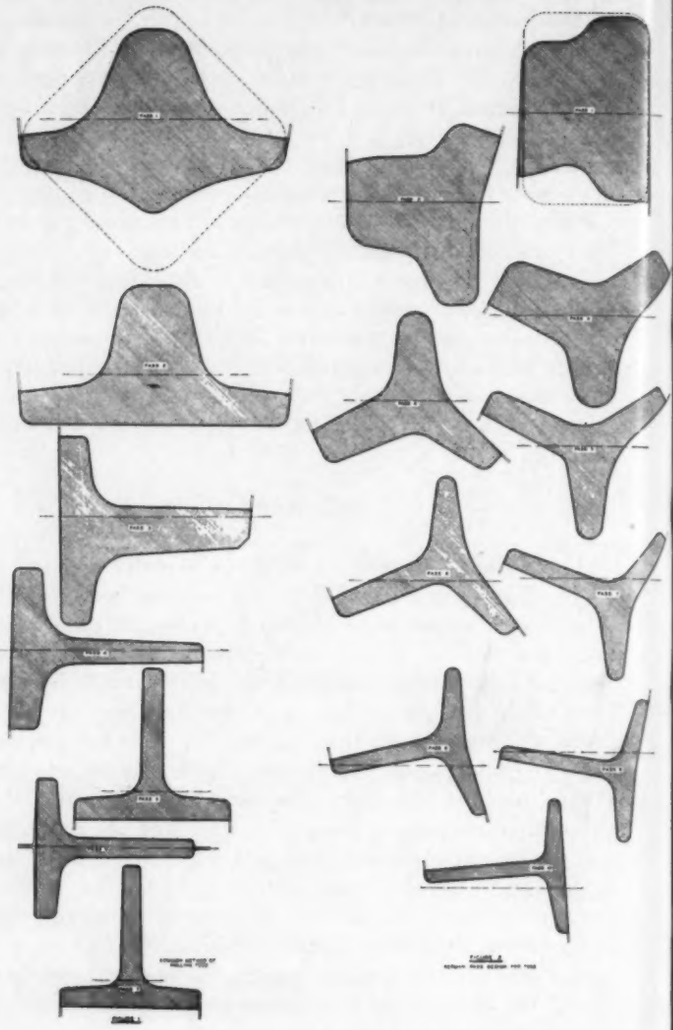
Drawing 26 — Passes from bloom to finishing in rolling 4 in. standard zee bar.

▲

Drawing 27 — Pass schedule for a very large uneven zee bar.

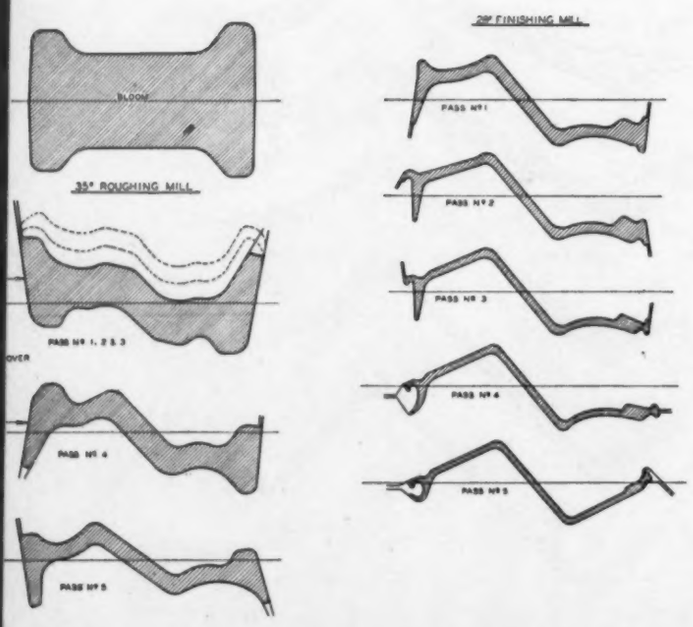






Drawing 28 — Passes used in rolling a reverse lock sheet piling section from a beam blank. (above left)

Drawing 29 — Passes used in rolling a z-piling section. (above right)



Drawing 30 — Two methods for rolling tees. (left)

lb to 18 lb and 8.2 lb to 12.5 lb weights coming from one roughing line and dividing into two lines at the leader pass.

Drawing 27 illustrates the passes for a very large and uneven zee bar. This is a 12 7/8 in. zee bar with one leg 6 7/8 in. long by 13/32 in. thick, and the other leg 4 in. long by 3/4 in. thick. The difference in the thickness of these legs makes the section a difficult one to roll. Starting as it does from a 5 3/8 in. thick slab, it is evident that the total draft on the short, thick leg can not be as great as that on the long, thin leg. In the first two passes, then, these drafts can not be proportionate. Commencing with the third pass, the drafts are proportioned correctly for all parts of the bar. The results of this lack of draft in the short leg in the first two passes are shown in the finished section by the shorter total length

of the short-leg side of the bar as compared to the long-leg side and the center portion. This short, thick leg cambers excessively to the thick side in cooling on the hot bed, making the bar a difficult one to roller straighten.

SHEET PILING

In addition to structural shapes, special shapes of various kinds are made on structural mills, and among these is piling bar. Piling bar is of the flat type or arched type, and in a few mills z-piling is also rolled.

Piling bar is considered difficult to roll. This is due in part to the large size of the sections, but is principally the result of the bending operation which forms the lock in the finishing passes. Passes must be lined up with relation to each other with great accuracy or the lock opening will be off-size.

Drawing 28 shows the passes for a piling bar, the locks of which are reversed — that is, one up and one down — one of the two sections of its kind rolled in this country. The advantage of this design is that there are only two diagonal passes in the whole series, the two diagonal passes converting one flange from the up position to a downward one.

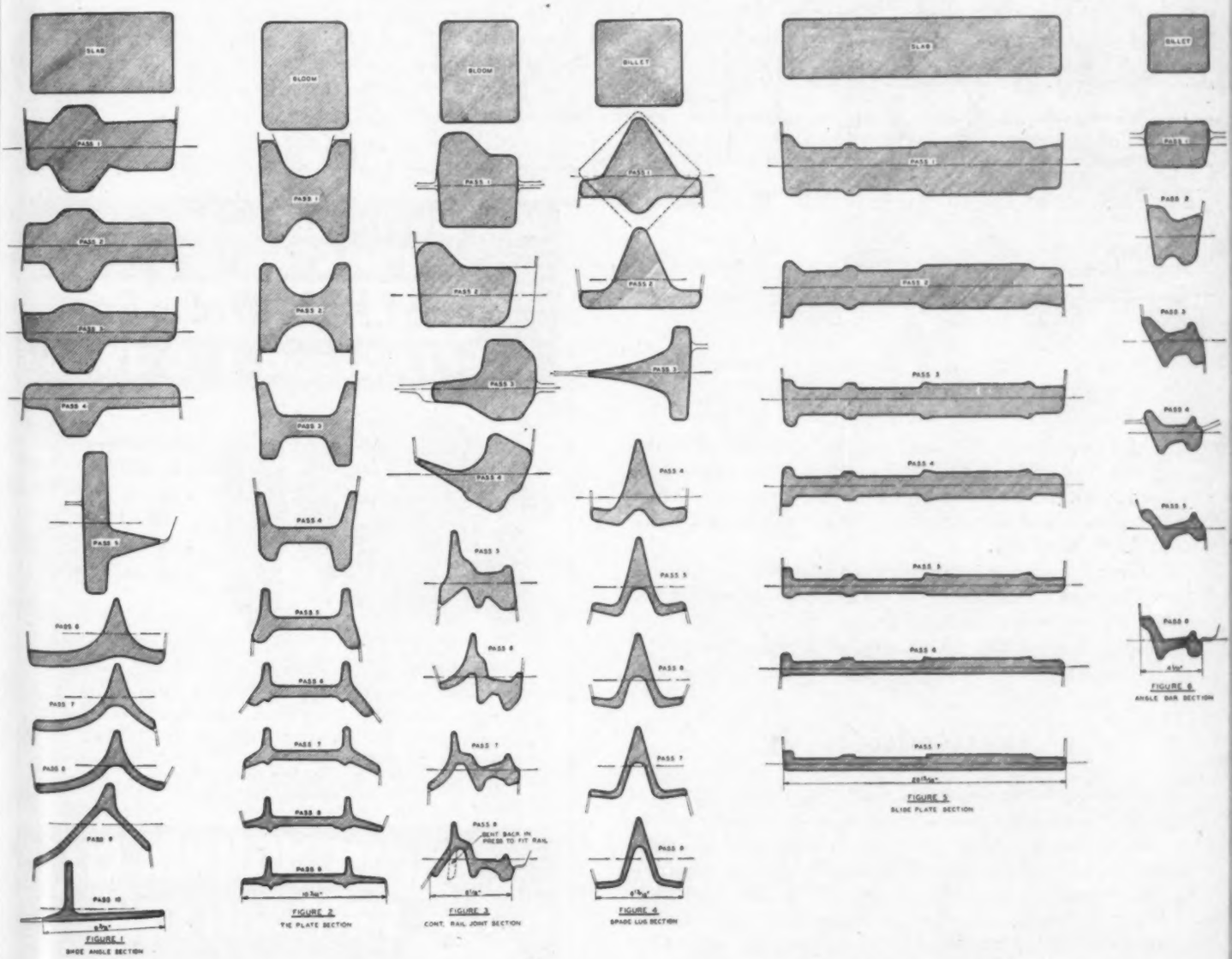
A spray of oil is used on the lock part of the last two passes in order to keep the passes smooth and to facilitate the bending process. If this oil is not used there is a lap on the end of the finger caused by the rubbing of the end of the flange finger against the roughened roll. In addition the lock will not be uniform in opening.

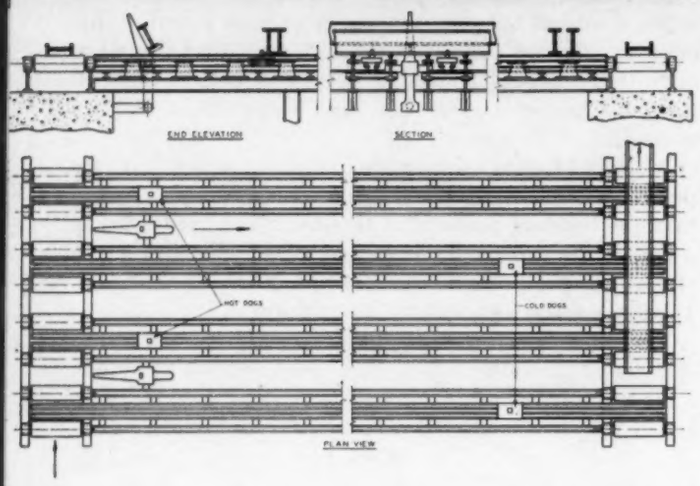
Drawing 29 shows a z-piling section and passes. A section of this kind has a very good section modulus.

TEES

Tees are not as commonly in use as beams, channels and angles, but are made in some structural mills. One

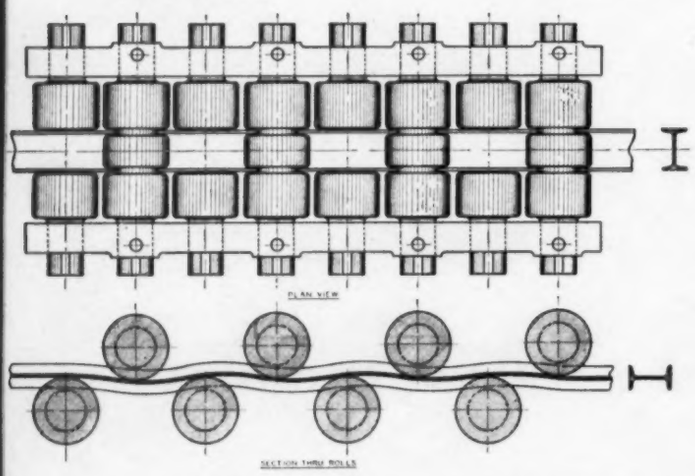
Drawing 31 — Pass schedules for miscellaneous sections.





Drawing 32 — Hot bed of type widely used in structural mills.

Drawing 33 — Sketch showing action of eight-roll straightener on beam.



of the most commonly used designs is shown on Drawing 30, Figure 1. In this design, the billet is introduced corner up. This method makes a tee shape in the first two passes, and the succeeding passes reduce this shape to the finished size.

Figure 2 on the same drawing illustrates a German design which employs a different principle in forming the section, requiring more passes than the first design shown. A great many tees are now being produced by slitting beams in two and restraightening them.

MISCELLANEOUS SHAPES

Drawing 31 shows a few shapes made on structural mills. Figure 1 is a shoe angle used instead of a tie plate. This section is used as a support for rails and rail joints. Figure 2 shows an unusual form of tie plate. Figure 3 illustrates the passes for a continuous rail joint, and Figure 4, the development of a spade lug section used on steel tractor wheels. Figure 5 shows the passes for a switch plate used at railroad switches, and Figure 6, the passes for an angle splice bar.

HOT BEDS

For cooling material, most structural mills use a flat rail hot-bed equipped with dogs, to move the material from the mill run-out table to the bed, and across and off the bed to the roller straighteners. Some of the structural mills have a turn-up device on the bed to turn beams and channels on edge for cooling. Drawing 32 illustrates the most common type of bed.

ROLLER STRAIGHTENER

After cooling on the bed, structural material is run through a roller-straightener located at the end of the discharge table of the hot bed. The machines most often used are the seven- or eight-roll types. The seven-roll machine is inferior to the eight-roll machine because heavy drafting can be taken only by the first top roll, while the eight-roll machine permits drafting by all top rolls. Drawing 33 illustrates the straightening action in an eight-roll straightener.

The purpose of presenting this paper on structural mills and roll design is to describe interesting mill layouts and to point out the progress that has been made in the rolling of structural materials, together with outlines of a few of the roll designs used in the mills. It is hoped the subject has been presented in such a manner that it will be of value to those who are interested in the subject.

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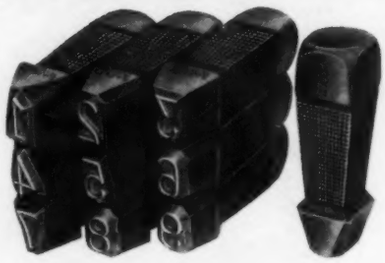

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▲ UNDER present conditions, practically all industry is faced with the problem of unskilled operators for all types of machines. These operators are not familiar with the fine points of operation which prolong the life and produce the most satisfactory performance of the equipment which has been placed in their hands. Furthermore, it may be difficult to obtain satisfactory delivery of replacement parts. It is essential, therefore, that new equipment be correctly selected and that both new and old equipment be properly maintained.

When selecting magnetic brakes, we should consider the purpose of the brake. Is the brake to be used to:

1. Stop the load without excessive drift?
2. Hold the load?
3. Stop the load accurately?
4. Stop the load frequently?

Torque capacity is usually the main factor in brake selection. For most applications, a brake having a torque rating equal to or slightly greater than full load motor torque is satisfactory. However, on some applications brakes are selected with a rating considerably less than, or greater than, full load motor torque. Before the advent of roller bearings on cranes brakes were seldom used on trolleys. However, brakes are now used to prevent excessive drift and to permit more accurate spotting of the load. Trolley brakes are usually selected on the basis of one half full load motor torque, although in some cases the brake torque may be even lower. Full load motor torque may be calculated from the formula:

$$T = \frac{5250\ hp}{N} \qquad (1)$$

where T = torque, lb-ft.
hp = rated motor horsepower
N = full load motor speed, rpm

For the majority of hoist applications, brakes having a torque rating equal to full load motor torque are satisfactory, because the friction of the drive assists the brake to hold the load and prevent overhauling. In direct current systems with dynamic braking, the magnetic brake acts primarily as a holding brake, although the magnetic brake usually assists dynamic braking to bring the load to rest. In alternating current systems, electrical braking has been seldom used, and the magnetic brake must stop the load as well as hold the load. The magnetic brake should then have a torque rating greater than full load motor torque in order to reduce slippage. If the load is of the overhauling type, the torque available for decelerating the load is the difference between the brake torque plus friction

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torque and the overhauling torque of the load. Obviously if the sum of the friction torque and brake torque is exactly equal to the overhauling torque of the load, the load will not be brought to rest. The greater the difference between these torques, the shorter the drift of the load and the less the wear on the brake lining. In some cases, particularly on large hoists, mechanical load brakes are used to bring the equipment to rest, and the magnetic brake is applied to hold the load.

When applying brakes to holding and closing lines of bucket hoists, it is desirable that one brake have sufficient torque capacity to hold the entire load. For example, the holding line brake must prevent overhauling of the load when the closing line brake is released and the closing line motor is operated to open the bucket.

On some machines it is essential that the brake bring the driven member to rest accurately and consistently at definite points in a cycle on successive operations. On other types of machines, it may be desirable that the brake stop the equipment in a very short interval of time. In many of these applications, magnetic clutches are used to cut off the motor rotor to reduce the energy that has to be absorbed by the brake, thus reducing the drift of the load after the brake applies. The time required for a brake alone to stop a moving mass is determined from the following formula:

$$t = t_a + t_d = t_a + \frac{120\ KE}{2\pi\ T\ N_b} \qquad (2)$$

where t = time, seconds, required to stop the moving mass after the brake is de-energized.
t_a = time, seconds, for the brake shoes to apply against the wheel after the brake is de-energized. This time varies with the type and size of brake used.
t_d = time, seconds, of drift of wheel after the brake shoes apply.
KE = total kinetic energy, ft-lb, in the moving system at the instant the brake applies.
T = retarding torque, lb-ft. This torque is the sum of the brake torque and the friction torque of the moving system. In most calculations for time of stop, the brake torque only is considered, unless the friction torque is high.
N_b = rpm of the brake wheel.

For a rotating body:

$$KE = \tfrac{1}{2}\ I\ \omega^2 \qquad (3)$$

where $I = \frac{W}{g}\ R^2$ = moment of inertia of the body, lb-ft²

$\omega = \frac{2\pi N}{60}$ = angular velocity, radians per sec

Equation (3) reduces to the more useful form:

$$KE = 1.7\ WR^2\left(\frac{N}{100}\right)^2 \qquad (4)$$

where W = weight, lb, of the rotating mass.
R = radius of gyration, ft, of the mass.
N = rpm of the mass.

For body with linear motion:

$$KE = \tfrac{1}{2}\ M\ v^2 \qquad (5)$$

or

$$KE = \tfrac{1}{2}\frac{W}{g}\left(\frac{V}{60}\right)^2 \qquad (6)$$

where v = linear velocity, fps.
V = linear velocity, fpm.
$g = 32.2$ = acceleration of gravity.

The factor WR^2 which appears in equation (4) is sometimes called the moment of inertia of the rotating mass. Actually the true moment of inertia is WR^2 divided by 32.2. However, the WR^2 of a rotating body is a useful factor to have when calculating acceleration and deceleration of moving masses.

If the machine contains only a few elements, the time required to stop the equipment can most readily be determined by calculating the kinetic energy of the various elements using equations (4) and (6) and then substituting the total energy for all the elements in equation (2).

If a machine has numerous elements, it is often convenient to forego calculations for the kinetic energy of each part, and simply determine the equivalent WR^2 of each element and use the total WR^2 thus obtained in equation (7). In the case of a rotating mass, equation (2) may be rewritten:

$$t = t_a + \frac{WR^2\ N_b}{308\ T} \qquad (7)$$

Equation (7) applies to a single rotating machine element or a group of elements all rotating at the same speed. If the machine has a number of elements which rotate at speeds different from that of the brake wheel (which is considered base speed), it is necessary to reduce the factor WR^2 of the respective elements to the common base speed. The equivalent WR^2 for a mass rotating at any speed other than the base speed N_b may be derived from the equation:

$$\text{Equivalent } WR^2 = W_1R_1^2\left(\frac{N}{N_b}\right)^2 \qquad (8)$$

In which $W_1R_1^2 = WR^2$ of the machine element at its actual speed N.
N = rpm of machine element rotating at a speed other than base speed.

When a machine has a combination of rotating and linearly moving parts, it is possible to determine the equivalent WR^2 of parts having linear motion by equating expressions (3) and (6) and solving for WR^2.

$$\text{Equivalent } WR^2 = W\left(\frac{V}{2\pi N_b}\right)^2 \qquad (9)$$

On overhauling loads, only a part of the brake torque is available for stopping the inertia load. That is, part of the brake torque is used simply to overcome the overhauling torque and the balance is available to decelerate the inertia load.

If T_1 = brake torque plus friction torque, and T_2 = overhauling torque, then $T_3 = T_1 - T_2$ = torque available for deceleration. Therefore, in the case of an overhauling load, T_3 would be substituted for T in equations (2) and (7) when calculating the time required to stop the moving masses.

It is evident from equation (2) that the only way to reduce the drift of the machine is to speed up application

of the brake or to increase the brake torque. In some cases, therefore, a brake may be selected with a torque rating appreciably greater than full load motor torque. It is important, however, that the brake torque is not so high that damage to the rest of the equipment will result.

Fundamentally, a brake converts the kinetic energy of a moving system into heat energy, and must dissipate that heat by conduction and convection. It is to be noted that, for all practical purposes, all the kinetic energy of motion is converted into heat. Therefore, a change in brake torque does not affect the amount of heat dissipated, except, of course, in the case of overhauling loads. Most of the energy absorbed by a brake is dissipated as heat from the brake wheel. The brake lining is a heat insulator and therefore can be neglected as far as heat dissipation is concerned. However, the maximum permissible wheel temperature is limited by the brake lining as well as by the wheel itself.

Asbestos contains about 14 per cent water of crystallization which begins to distill off at approximately 500 F and the rate of distillation increases as the temperature increases. The inherent characteristic of asbestos fibers to hold together decreases in proportion to the loss of water of crystallization. Organic binders in linings oxidize and deteriorate at 450-500 F. Inorganic binders have greater resistance to elevated temperatures but are more likely to score brake wheels. Since in most cases organic binders are used, it is good practice to keep the wheel temperature below 400 F.

Hard and fast rules for the amount of energy which a wheel can safely dissipate in a given period cannot be set up because of the numerous variables encountered in service. Heat dissipating capacity of wheels depends on:

1. Wheel surface area.
2. Peripheral velocity. There is better cooling at high speeds.
3. Time cycle. There is better cooling when the wheel is rotating.
4. Ventilation. Heat capacity is reduced if ventilation is restricted.

Manufacturers usually limit the horsepower of the motor with which specific sizes of brakes should be used. This limiting horsepower is given simply as a rough guide to brake heat capacity and is somewhat arbitrary, because of the varying service conditions to which a motor may be applied. Standard lines of brakes for mill motors, as set up by the various manufacturers, take into account both the torque and heat capacity of the brakes for the general steel plant application.

On certain applications, where the frequency of operation is high or where the energy of motion is large, special consideration must be given to the heat energy to be dissipated by the wheel. On those jobs, complete data should be given to the brake manufacturer, so that he can select the proper brake for the specific application. The information which should be given to the brake manufacturer is as follows:

1. Description of the application.
2. Speed of the brake wheel.
3. Frequency of stopping.
4. Accuracy of stopping required.
5. Length of time that the wheel rotates.
6. Length of time that the wheel is stationary.
7. Kinetic energy at full speed in the load to be stopped by the brake.
8. If the machine has a combination of overhauling and inertia loads, the magnitude of the overhauling torque should be given, or data provided so it can be calculated.

With the above information, the manufacturer can calculate the energy which must be dissipated in the brake.

The speed of release and application of brakes must sometimes be taken into consideration, particularly on repeating cycles where time is at a premium, or where accurate, consistent stopping is required. On other applications, such as on crane bridges, it is desirable to bring the drive to rest before applying the brakes. As

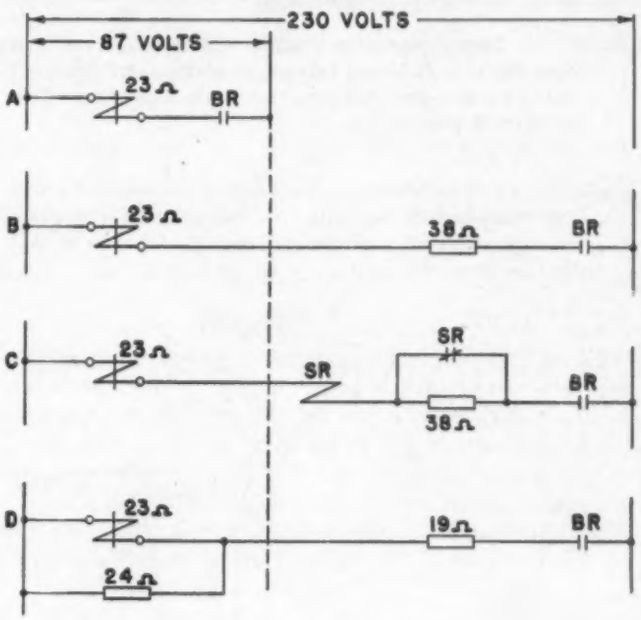
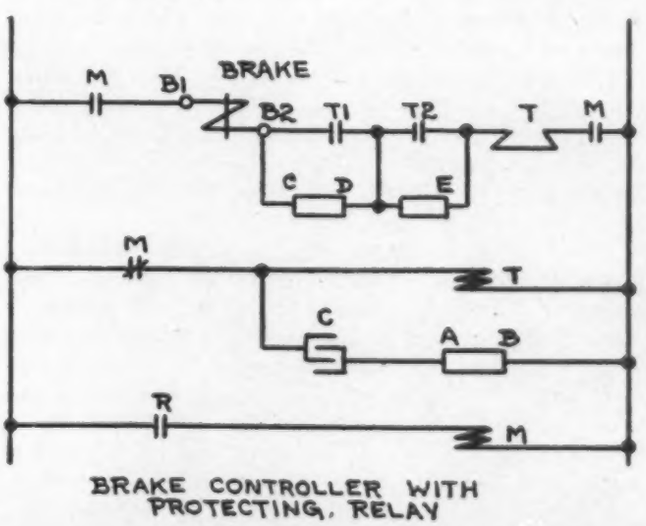


Figure 1 — Simple circuit diagrams for magnetic brakes with full voltage and partial voltage coils.

Figure 2 — Line diagram for controller with brake protecting resistor cut in by a condenser timer relay.



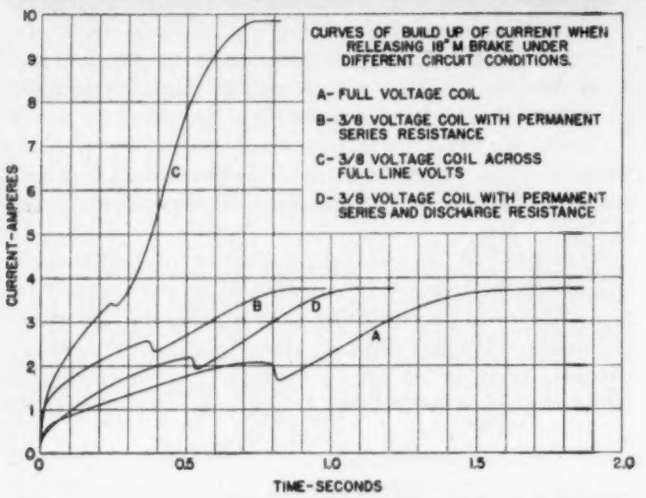
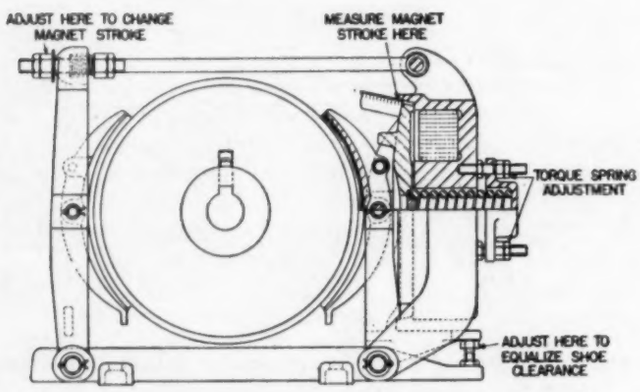


Figure 3 — Curves showing change in brake current with time for the different circuit conditions of Figure 1. These curves were transcribed from oscillograms for an 18 in. brake.

▲

Figure 4 — Typical short stroke d-c clapper magnet brake. The inner pole of the armature is recessed 1/32 in. below the outer pole to prevent slow application due to residual magnetism.


ADJUST HERE TO CHANGE MAGNET STROKE
MEASURE MAGNET STROKE HERE
TORQUE SPRING ADJUSTMENT
ADJUST HERE TO EQUALIZE SHOE CLEARANCE

indicated in equation (2), when calculating the time required for decelerating a load, it is necessary to include the time for the brake to apply. This is very important because, during this interval, the load is rotating at practically full speed, but after the shoes apply, the average speed is roughly one-half of full load speed. Thus, under certain conditions, it may require one-half second for a brake to apply and another one-half second to stop the load after the shoes apply against the wheel.

Short stroke brake operating magnets are generally faster on both release and application than long stroke magnets. That is why clapper magnet operated brakes are usually speedier than solenoid operated brakes of equal torque rating. When fast release is required, it is essential that the brake stroke be properly adjusted and that this adjustment be maintained as the lining wears. The speed of operation of d-c brakes can be more readily controlled than the speed of operation of a-c brakes. In the following paragraphs, several methods for controlling the speed of d-c brakes are discussed.

Direct current shunt brakes may be wound with full voltage coils or with partial voltage coils protected by a series resistance. The partial voltage coil with the protecting resistance connected permanently in series is used to speed up release of the brake by reducing the time constant (ratio of inductance over resistance) of the circuit. When exceptionally fast operation is required, a low voltage coil may be connected across the line momentarily until the brake is released, at which time a protecting switch may operate to insert a resistance in series with the coil to prevent burn out.

Figure 1 shows simple circuit diagrams for brakes with full voltage and partial voltage coils. A full voltage coil is used in Figure 1-A and a partial voltage coil with a permanent series resistance is used in Figure 1-B. Figure 1-C has a partial voltage coil with a protecting resistance inserted after the brake releases. The protecting switch is energized by a coil in series with the brake coil. There are other methods of operating the protecting switch. For example, a contactor with time delay obtained from a condenser timer might be used as shown in Figure 2.The circuit in Figure 1-D has a partial voltage brake coil with permanent series and discharge resistances. This arrangement is sometimes used when slow application of the brake is desired.

The curves of Figure 3 show the rate of build up of brake current for the various circuit conditions of Figure 1. The curves were transcribed from oscillograms made on an 18 in. brake rated at 900 ft-lb for intermittent duty. The same brake and brake coil were used in all tests. That is why in Figure 1-A full coil voltage is 87 volts. The dips in the curves indicate the point at which the brake releases. The curves illustrate that the speed of release of brakes is increased appreciably by the use of partial voltage coils. When the speed of application is delayed by means of a discharge resistance, the question sometimes arises whether or not the speed of release will change. Curve D indicates that, with a partial voltage brake coil, the speed of release is decreased when a permanent discharge resistance is used.

The simplest way to speed up application of a d-c brake is to place a non-magnetic spacer between the field and armature members of the magnet to prevent seal of the magnet faces. Figure 4 illustrates a typical short stroke d-c clapper magnet brake. The inner pole of the armature is undercut approximately $\frac{1}{32}$ in. below the outer pole to interpose an air gap in the magnetic circuit when the magnet is energized and the brake released. This gap prevents the magnet from sticking on residual magnetism and speeds up application of the brake. Brake application can be further speeded up by adding a bronze spacer between the pole faces, so that there is no magnetic seal at the outer poles of the field and armature. This arrangement is not feasible on series wound brakes where the brake must hold in on 10 per cent of full load motor current.

The time required to apply a shunt brake can be increased by connecting a discharge resistance around the coil. The lower the ohmic value of the discharge resistance, the longer will be the time required to apply the brake. Sometimes a short circuited turn of copper is used in the coil to increase the time of application.

The question of whether an a-c or d-c brake should be used on a particular application is usually settled by

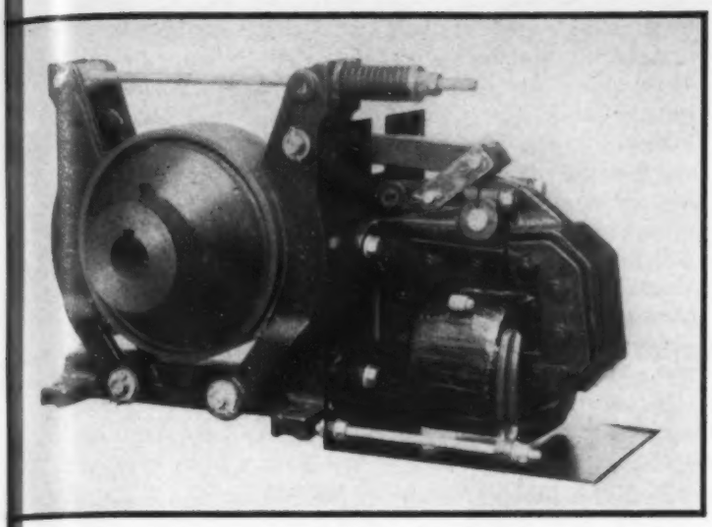


Figure 5 — Short stroke a-c clapper magnet brake with protecting cover for magnet removed.

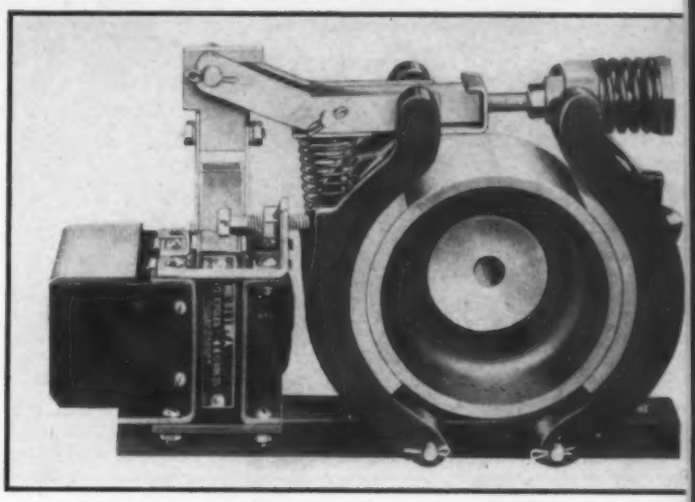


Figure 6 — Small a-c solenoid operated shoe brake designed for constant stroke to reduce the possibility of coil burnout.

the type of power used on the motor. However, because d-c brakes are generally more rugged than a-c brakes, they may be used in conjunction with rectifiers on installations where the primary source of power is a-c. On applications where accuracy in stopping is of prime importance, d-c clapper magnet or solenoid brakes may be used because they are more constant in their time of application. The a-c magnet brake may, on the average, require less time to apply, but the time lag in a-c brakes is dependent upon the position in the a-c wave that power is cut off.

Brake windings are either series or shunt. Series brakes are connected in series with the motor armature and are connected to power and disconnected from power by the same contactors which control the motor armature. Shunt brakes are connected to the line either alone or in series with a protecting resistor and have the disadvantage that extra wires, and usually an additional contactor, are necessary. Alternating current brakes are shunt wound only, while direct current brakes may be either series or shunt.

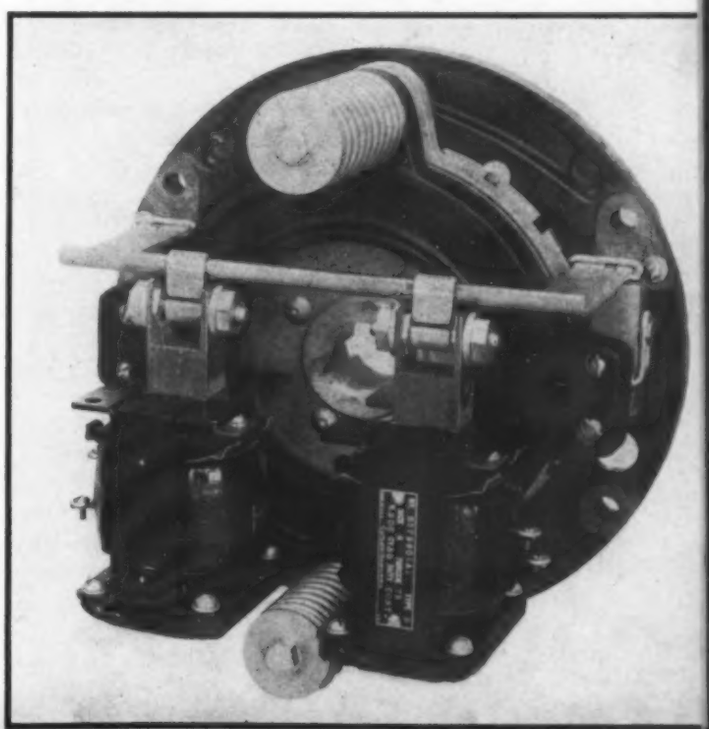
Series brakes rank high from the standpoint of safety, because the series coil insures that sufficient current is applied to hold the motor before the brake will release. Series brakes are inherently fast operating due to the low inductance of the coil. Series brakes do have some disadvantages; 40 per cent full load motor current is required to release the brake and 10 per cent full load motor current is required to hold the brake released. Therefore, if the load is extremely low, the brake will not remain released, but may chatter. Furthermore, the brake coil resistance may be an appreciable part of the circuit resistance, so that there is a pronounced drop in motor voltage and a drop in full load motor speed. This condition is most noticeable on small brakes.

Brakes with shunt windings have the advantage that, when once released, they will hold released regardless of the load on the motor. Because of their high inductance shunt brakes are more sluggish in operation than series brakes. However, this sluggishness may be overcome by the methods previously discussed. When installing shunt brakes, be sure to connect the protecting resistance in series with the coil. The brake nameplate will usually indicate whether or not a protecting resistance is necessary. For example, the nameplate may specify that the line voltage is 230 and the coil voltage 115. This immediately indicates that a protecting resistor is required.

Brakes are rated on the basis of the torque which they can deliver over a period of time without overheating of the brake coil. The coil should have the same time rating as the motor with which it is used. However, if the equipment is overmotored in order to permit low loads for greater periods of time than the time rating of the motor, the brake coil should be designed to take this fact into account. Brakes may be classified as follows with respect to duty:

1. Series brakes are rated:

Figure 7 — A-c disc brake operated by two solenoids to provide compact structure. This brake is designed for motor mounting. The protecting cover has been removed to show the internal parts.



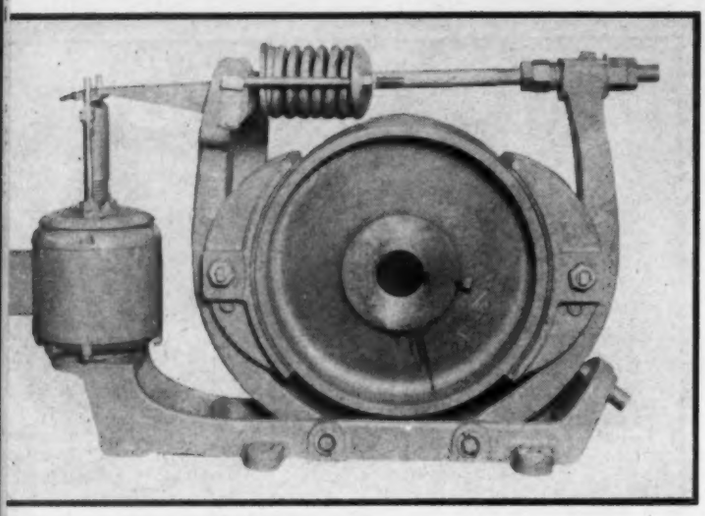


Figure 8 — A-c torque motor operated shoe brake. This brake can be arranged for horizontal or vertical base mounting or for side wall mounting. ↑

Figure 9 — Outline drawing of the a-c motor operated brake shown in Figure 8. Note the construction of the anti-friction ball jack. →

(a) ½ *hour duty*. This rating means that the brake coil will carry full load motor current continuously for ½ hour without overheating. This duty also corresponds to one minute on, two minutes off, or ⅓ time duty.

(b) 1 *hour duty*. This rating means that the brake coil will carry full load motor current continuously for one hour without overheating. It is equivalent to one minute on, one minute off, or ½ time duty.

2. Shunt brakes are rated:

(a) *Intermittent*, 1 *hour duty*, which indicates that the coil, in conjunction with its protecting resistance (if used), can be placed across the line continuously for one hour without excessive temperature in the coil. This duty rating corresponds to one minute on, one minute off, or ½ time duty.

(b) *Continuous duty* means just that. The brake, together with its protecting resistor (if used), can be connected across the line continuously without exceeding safe temperatures.

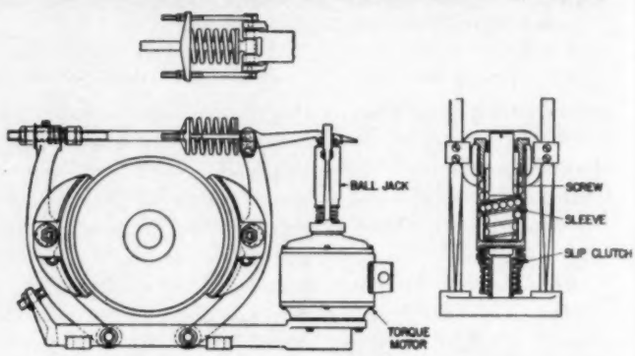
(c) *Special duty* — Sometimes, because of conditions peculiar to a particular application, the brake coil may be designed for a short time duty cycle, or for frequent operation where the inrushes to the coil determine the ultimate temperature rise. This is particularly true on a-c brakes where the coil inrushes are high. These applications require special analysis by the brake manufacturer.

There are three basic types of magnetic brake operators:

1. Clapper magnet.
2. Solenoid.
3. Motor.

The clapper magnet operator has low inertia and short stroke and is, therefore, faster operating and has longer life than solenoid operated brakes. The a-c clapper brake shown in Figure 5 has a magnet similar to that used on a-c contactors.

Solenoid brakes have comparatively long strokes. Generally, as the lining wears, the stroke increases, and on a-c brakes the solenoid stroke must be readjusted before the gap becomes excessive and the coil burns out because the solenoid will not seal. In the case of the a-c solenoid operated brake shown in Figure 6, the stroke remains constant as the lining wears, so the coil will not burn out because of excessive stroke. Due to their large stroke, solenoid brakes tend to hammer themselves to pieces, particularly if the torque spring pressure is reduced. A-c solenoid operated brakes are not used in large sizes, usually not above the 10 in. size, because of high inrush wattage and current. Two small solenoids are used to operate the disc brake illustrated on Figure 7 in order to obtain a more compact unit and to reduce the inrush wattage.



Motor operated brakes have the advantage of being quiet in operation and are therefore often used on elevator service. One disadvantage is that they are quite sluggish in operation due to the relatively high inertia of the rotor. This feature is sometimes an advantage when a time delay is desired between the time that power is cut off and the brake is applied. Motor operated brakes are often designed to release the brakes in only one direction of rotation, so separate directional switches are required to properly release the brakes when used in conjunction with reversing motors. The motor operated brake illustrated in Figure 8 overcomes one objectionable feature of solenoid operated a-c brakes — it has low inrush watts. The rotating magnet or torque motor has a constant air gap which is quite large. The running and stalled watts are therefore practically the same. Figure 9 is an outline drawing of the brake of Figure 8 showing the operating mechanism in greater detail. Note in the enlarged view of the ball jack that the screw rides on hardened steel balls. This construction makes the ball jack highly efficient. In operation, the torque motor and ball jack make 3 ⅓ revolutions and the screw extends 1.6 in., thus raising the operating lever and releasing the brake. When power is disconnected from the torque motor, the overhauling force of the brake torque spring reverses the operating motor and applies the brake.

Magnetic brakes may also be classified as:

1. Shoe brakes.
2. Disc brakes.
3. Band brakes.

Shoe brakes are characterized by good heat dissipating capacity, ruggedness, and ease of adjustment.

Disc brakes are compact and suitable for motor mounting. However, they have low heat dissipating capacity and are limited to applications where the service is not too severe.

Band brakes have fair heat dissipating capacity. They have unequal braking torque for opposite directions of rotation and, because they are not free releasing, are often times difficult to adjust.

Most brakes are designed with reasonable leeway for mounting. This is particularly true of brakes with self-aligning shoes. Small brakes in which the shoes and shoe levers are integral require more care in mounting. The same is true of most band brakes. The majority of shoe and band brakes are designed to be mounted with the base in the horizontal plane. However, some brakes can with minor modifications be arranged for vertical shaft mounting, ceiling mounting, vertical mounting or side wall mounting. The vertically mounted clapper magnet shoe brake in Figure 10 has an "L" shaped base to permit mounting the magnet structure above the wheel. This construction is used where floor space is at a premium. All brake adjustments are at the top of the magnet for ready accessibility.

Brakes should not be exposed to oil, water or dust without adequate protection. Oil, even in small quantities, reduces the coefficient of friction of brake linings. Water in small quantities does not have an appreciable effect on the coefficient of friction, because the water squeezes out as the lining applies against the wheel. However, if the amount of water is excessive, it will cause a lowered coefficient. Protective enclosures may be drip-proof, weather-proof, water-tight or dust-tight. When protective enclosures are used, it is desirable to have adjustments reasonably accessible. In the case of drip-proof and weather-proof enclosures it is possible to arrange the construction so that the enclosure can readily be moved out of position for adjustments. More difficulty is encountered on brakes with water-tight and dust-tight enclosures. However, Figures 12 and 13 show a split type, water-tight, dust-tight enclosure in which the cover only has to be removed to make all adjustments accessible.

The importance of periodic inspection and proper maintenance of brakes cannot be overstressed. The frequency of inspection and adjustment depends upon the severity of service. The major points to be checked when making periodic inspections are:

1. Stroke of magnet.
2. Torque adjustment.
3. Brake shoe clearance.
4. Lining condition.
5. Wheel condition.
6. Tightness of mounting bolts.

The most important part of brake maintenance is brake adjustment. It is essential that the brake magnet stroke be reasonably maintained. If the stroke is excessive, the brake will set with shock to the brake and connected apparatus. The current required to release the brake will increase and the speed of release will decrease. In the case of series brakes, a large stroke may require the operator to advance the controller beyond the first point to release the brake and start the motor.

The torque spring of the brake should not necessarily be adjusted to the compression designed to give rated torque. The spring should be adjusted to produce a smooth stop with reasonably fast release and application.

The brake should be adjusted to insure clearance between the shoes and wheel. If the shoes ride the wheel,

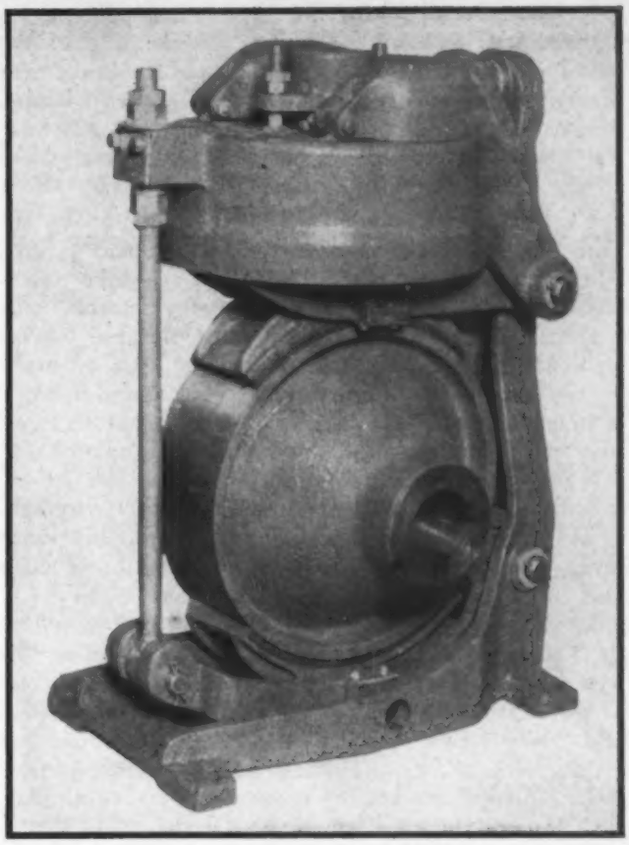


Figure 10 — Vertical 14 in. d-c brake for use where floor space is at a premium, or where standard horizontal brakes interfere with jack shafts.

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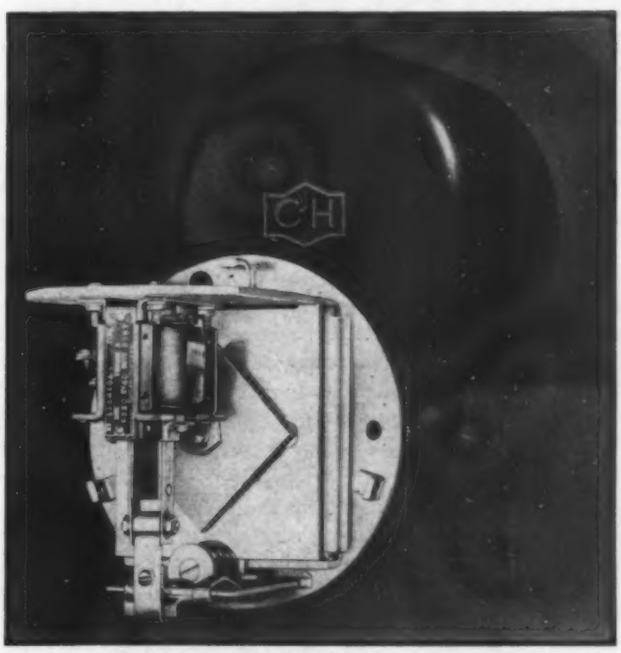
Figure 11 — This solenoid operated 5 in. disc brake is designed for mounting on the end bell of a motor. In service, the brake is enclosed for protection.



unnecessary wear of the linings and heating of the wheel will result. Improper mounting of the brake may prevent proper adjustment of shoe clearances. Brakes designed for horizontal base mounting may not have the correct shoe clearance adjustment for vertical or ceiling mounting.

For best results, use repair parts recommended by the brake manufacturer. Many troubles are encountered when this practice is not followed. The brake manufacturer has undoubtedly made tests to determine the material and parts which are most suitable for his particular device. This is particularly true of brake linings and wheels. Linings and wheels go hand in hand. A lining which is satisfactory with one type of wheel may be a complete failure with another type of wheel. It is good practice, therefore, to follow the recommendation of the brake manufacturer when buying a replacement wheel or lining. He has probably made exhaustive tests to determine the combination of lining and wheel which he furnishes in his brake.

Low coefficients of friction are usually obtained on new linings due to handling. The natural oil on the hands is sufficient to noticeably reduce the coefficient of friction. Also, in any shop it is difficult to keep oil and grease from machinery surfaces. That is one reason for selecting brakes with some factor of safety, particularly on applications where the load is overhauling. Static and dynamic coefficients of friction are practically the same for most good linings, although some linings show a decrease in coefficient of friction and some linings show an increase in coefficient of friction at extremely low speeds and under static conditions.

Lining life is another important factor in the selection of linings. A lining which may have a good life with one type of wheel may have unsatisfactory life when used with a different type of wheel. That is another reason for using the matched wheel and lining recommended by the brake manufacturer. In general, it has been found that linings with the highest coefficient of friction show the greatest tendency to score brake wheels. Those linings are termed "hard linings."

Linings are usually attached to the shoe or disc by means of rivets. Linings should be replaced before the rivet heads come in contact with the wheel surface. New linings should be counterbored so that the rivet heads are below the lining surface. All rivets should be body tight in the shoe in order to prevent play which might cause rivet failure by shear if subjected to shock. This is particularly true on applications where the direction of rotation of the brake wheel reverses.

Cast iron brake wheels are usually satisfactory with any lining for light service and limited speeds, although the wheel wear will vary with different linings. For the same rigidity, the weight of the cast iron wheel must be increased over that of a steel wheel, so the flywheel effect is increased.

Steel wheels without heat treatment are satisfactory with some linings for light service and fairly high speeds. However, at pressures above 20 or 30 psi, they are easily scored by most linings. Those linings which do not score the wheel usually have relatively short life. They are called "soft linings."

Steel wheels which have been hardened are satisfactory for any lining for practically all service conditions unless the wheel temperature is excessive.

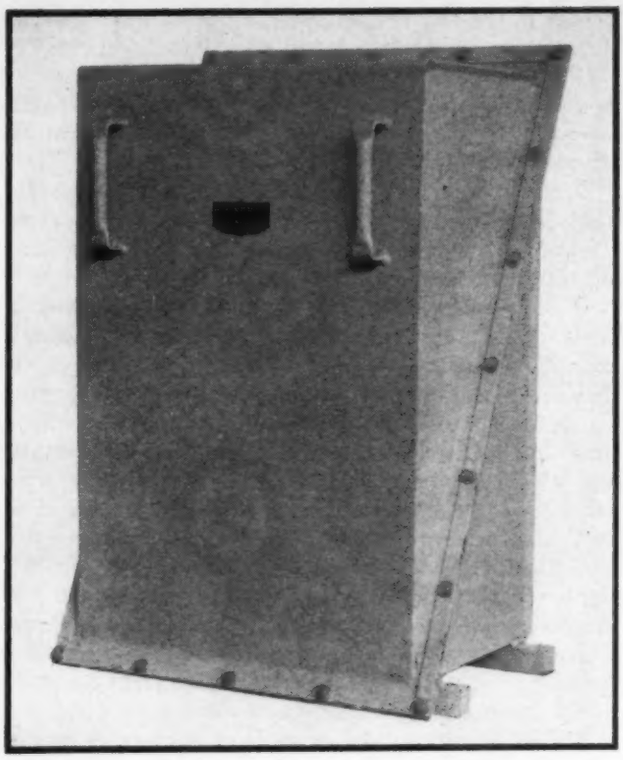
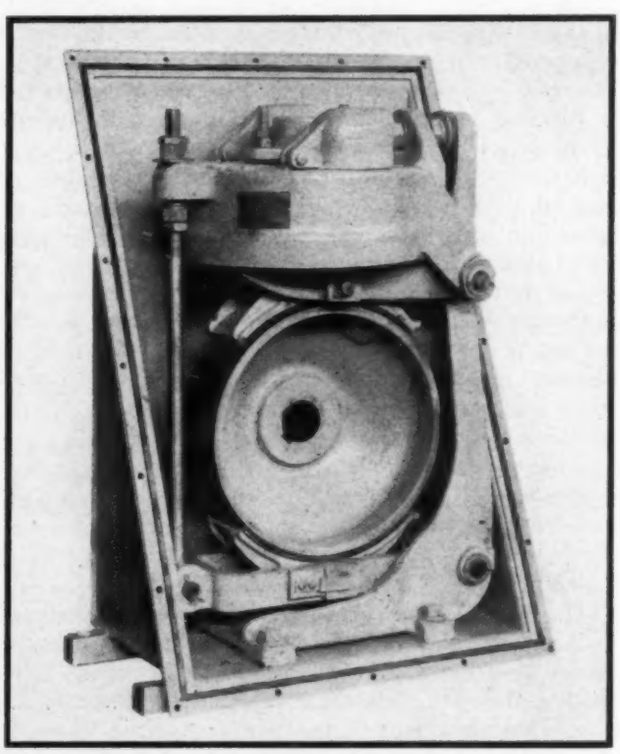


Figure 12 — N. E. M. A. 4-5 enclosure for vertical brake. The case is split on a diagonal to make the brake parts accessible when the cover is removed.

▲

Figure 13 — This photograph shows the brake of Figure 12 with the cover removed. The brake adjustments are at the top of the magnet structure to simplify maintenance.



In conclusion, the proper selection of brakes is not difficult if the requirements of the specific application are kept in mind. Brakes having a torque rating equal to full load motor torque are satisfactory for the majority

of applications. If the load is overhauling and the efficiency of the drive is high, a brake having a torque rating greater than full load motor torque is desirable, particularly if the machine may be overloaded. If the equipment must stop at a definite point on successive operations, the energy to be absorbed by the brake will determine the torque required. On those applications where the brake must stop a load more frequently than once a minute, the heat dissipating capacity of the brake should be checked.

The speed of operation required in the brake may determine the type of brake to use. D-c brakes are usually more rugged than a-c brakes, and have the additional advantage that the speed of application and release are more readily controlled.

A brake may be properly selected and still give unsatisfactory performance due to inadequate maintenance or improper adjustment. Proper maintenance and adjustment are vital to keep repairs to a minimum. Brake linings and wheels go hand in hand, so it is good insurance to use the material recommended by the brake manufacturer.

DISCUSSION

PRESENTED BY

J. D. LEITCH, Chief Engineer, The Electric Controller and Manufacturing Company, Cleveland, Ohio.

C. G. DIMITT, Engineer, Carnegie-Illinois Steel Corporation, Chicago, Illinois.

J. H. MILLER, Electrical Superintendent, International Harvester Company, Wisconsin Steel Works, Chicago, Illinois.

R. W. GRAHAM, Superintendent Electrical Department, Bethlehem Steel Company, Lackawanna, New York.

A. E. LILLQUIST, Supervising Engineer, Cutler-Hammer, Inc., Milwaukee, Wisconsin.

J. D. Leitch: It has been my experience that the selection of the coil for series brakes is often dealt with too lightly and I would like to add a few remarks to those made by Mr. Lillquist on the application of series magnetic brakes.

Most of the manufacturers of electric brakes build about seven different sizes varying in torque from 100 to 7000 lb-ft. Any one of these sizes will cover an adjustable range of torques and the series coil is selected to operate with a particular motor at some definite torque value within this range. Thus any one size of brake has a number of coils varying in wire size and number of turns.

We normally select the coil on the basis of the full load current of the particular motor with which it is to operate. In most cases, this is quite satisfactory. If, however, a particular job is over-motored and we choose a coil in terms of the motor rating, we are likely to run into trouble due to setting of the brake on light loads. This results in repeated release and setting of the brake with consequent overheating and checking of the wheel face. This could have been taken care of easily by the selection of a coil having a greater number of turns of smaller wire.

Another difficulty we have run into in the selection of series brake coils is just the reverse of the above, when the duty cycle is very severe or when the motor is greatly overloaded. I have known cases where the brake coils would reach temperatures much beyond their rating but on investigation have frequently found a large blower directed on the motor. In one case, the rms current on the motor was 160 per cent full load. Again it is an easy matter to take care of such a difficulty by the selection of a coil with less turns of larger wire.

I mention these two common examples of improper selection of series coils because they are important to users as well as to brake manufacturers. If we know the load conditions in these exceptional cases, we can easily make the proper selection of the coil in the first place and save time, trouble and expense.

C. G. Dimitt: We would like to point out that too frequently many of the factors mentioned by Mr. Lillquist are given very little consideration when new brake installations are being designed.

One factor in design layouts which we have found merits careful consideration is that of determining the maximum allowable speeds. Some time ago, on a number of dynamic lowering controllers, the lowering speeds were increased 200-250 per cent on crane hoists powered by 135 hp, 410 rpm motors. Consideration of equation (4) in Mr. Lillquist's paper indicates that for a 25 per cent increase in speed, there will be more than 50 per cent increase in the energy which the brake must dissipate.

$$KE = 1.7 \times WR^2 \times \left(\frac{820}{100}\right)^2$$

$$= 1.7 \times WR^2 \times 67 \text{ for 200 per cent speed}$$

$$KE = 1.7 \times WR^2 \times \left(\frac{1025}{100}\right)^2$$

$$= 1.7 \times WR^2 \times 105 \text{ for 250 per cent speed}$$

For the speeds indicated, the increase in energy is in the ratio of $\frac{105-67}{67} = \frac{38}{67}$ or 57 per cent. Because of the frequency of operation, the increase in energy dissipated by the brakes resulted in greater wear and more frequent renewals of brake wheels, shoes, and other parts. The slight improvement in operation due to the change in speed did not justify the additional maintenance required and consequent loss of time. The speeds were later reduced to their previous values.

For special duty applications requiring unusual performance, we have found that care must be exercised in combining controller, motor, and brake characteristics. A controller designed for use with a motor having a one hour or greater time rating may give current values which will result in unsatisfactory brake performance if the brake winding is designed for the ½ hour or less motor rating, particularly if the brake is adjusted to give 100 per cent or more of rated torque.

In the design and layout of crane and mill auxiliary drives, machine builders are frequently faced with getting a maximum of equipment into a minimum of space. This may result in brakes being so located that

it is necessary to remove a motor in order to remove the brake shoe hinge pins. When this is the case, the comparatively simple job of changing brake shoes assumes the proportions of a major job, requiring much more time, and more men.

One method of providing a more accessible brake mounting is to utilize the extension of the high speed shaft on gear reducer units. This method not only has the advantage of providing a more accessible location, but in addition it places the brake where a motor or armature may be changed without disturbing the brake adjustments, eliminating the handling and changing of the brake wheel.

For crane hoists requiring the use of two brakes, the use of a high speed shaft extension for one of the brakes not only meets the safety requirements of providing a brake to hold the hoist in the event one of the brakes has been dismantled to permit a motor or armature change, but it also permits the use of duplicate brakes, without sacrificing any torque capacity. This is not usually the case where the backshaft is used for the location of the second brake required.

Not all of the difficulty in removing hinge pins to change brake shoes is due to the machine builder's design layout. When the machine builder or our own shops do such a good job of painting that they include the exposed portions of hinge pins, they may also be arranging for the field maintenance man to spend many unnecessary hours in removing pins before brake shoes can be changed.

Brakes exposed to extreme mill dirt, moisture, or weather conditions may also have the exposed sections of pins become coated or rusted sufficiently to prevent easy removal. We have seen pins being sledged out so severely that the center portion of the pin actually telescoped out of the hardened shell without materially moving the pin through its bearings.

In an effort to prevent the corroded portion of the pins jamming in the bearings, some experiments have been made using grease fittings to lubricate the bearings. However, the lubricant does not readily work its way along the exposed portions of the pins and we are right back where we started. Recently, arrangements were made to provide a split thin wall tubing over the exposed sections of the pins which we hope will keep the covered sections of the pins clean and clear of paint, rust, or other mill adhesive deposits. As none of these units have been put into service, no reports are available.

In connection with the exposure to mill and weather conditions, it is frequently found necessary to store brakes, either before or after mounting in place on drives, for sometime they are placed into actual service. In such cases the brakes and other mechanical parts of the drives are subject to deterioration which may seriously affect performance when the equipment is put into service. It is our understanding that some of the machine builders have been experimenting with protective coatings which can be painted on to preserve machinery exposed to corrosive atmospheres. If such coverings can be easily applied to brake parts without causing damage, will last indefinitely and still be readily removed when desired, there would seem to be possibilities in using such materials to protect brakes and drive parts on equipment in storage as well as in service.

Mr. Lillquist has mentioned a maximum wheel operating temperature of 400 F. How can a maintenanc man determine whether or not this temperature has been reached without the use of fragile thermometers or other temperature indicating instruments? One of our maintenance men has come up with the idea of carrying a piece of string solder which melts at approximately 400 F. A brake wheel suspected of reaching an excessive temperature can be readily tested to see if it will or will not melt the solder when the operating temperature has been reached.

Another factor in brake performance mentioned by Mr. Lillquist is the matching or combination of brake wheel and lining characteristics by the manufacturer. In attempts to obtain increased wheel life, lining life, or both, experiments are frequently made with materials other than those furnished by the brake manufacturer. This is particularly true of lining materials. Experience has shown that when increased life is obtained, it may be at the expense of some other characteristic, such as torque output. Therefore, the results of changes in the manufacturer's materials should be carefully analyzed and evaluated before making such changes permanent. Too frequent renewals of wheels and shoes may be an indication of poor adjustment or of improper brake application. A change in materials may aggravate such conditions.

Too frequent renewals may develop on brakes which are properly applied and maintained. Where service conditions have not changed and renewals are the same as original parts, excessive shoe renewals can usually be traced to improper applications of linings in the maintenance shop. Linings must be of the proper size and shape with drilled holes not larger than the rivet diameter, and be tightly installed with the correct type of rivet for the brake in question. An analysis of the brake manufacturer's standards and methods in doing this work of relining provides a good starting point in setting up similar standards and methods for relining in mill shops.

The importance of brake adjustments has been pointed out by Mr. Lillquist. We believe that the improper adjustment of brakes is the one greatest cause of trouble with brakes properly applied. Why are brakes improperly adjusted? In most cases the men who make the adjustments do not know the proper procedure for correct adjustment. In general, an attempt is made to train men in the adjustment of brakes, using the manufacturer's instruction sheets as a basis. This instruction is usually given at a maintenance office or shop, and normally there are no brakes set up to practice on. In most cases, too, it is impractical for the maintenance men to carry the instruction sheets to the job, even if they knew they were going to do that type of work, because of the grease and dirt encountered. Therefore, we should like to see all of the brake manufacturers adopt as standard the provision of an instruction plate of durable, legible construction, mounted on the brake itself. The manufacturers usually find a favorable spot for installing their nameplates. Similar arrangements could be made for the installation of the instruction plate. This instruction plate should contain simple, brief instructions in proper sequence for making correct brake adjustments. The data should include the proper air gap or stroke required, and the spring compression which will give rated torque.

Two very common causes of poor brake performance due to maladjustment are too great air gap or stroke, and too great torque spring compression. To prevent the use of excessive torque spring adjustments we have installed a number of brakes equipped with stops welded into position so that spring compressions are limited to a pre-determined value. For most cases the stops have been provided to give 100 per cent rated torque. For special applications where the brake size or capacity installed was determined by factors other than torque rating, the stops were located to give the desired torque at values appreciably less than 100 per cent rated torque. The use of these stops has given very good results.

To simplify the adjustments necessary to give the desired air gap or stroke, we would like to see brake manufacturers provide as standard equipment on their brakes an index and scale arrangement properly graduated to read directly the movement made from the set to the release positions.

We would also suggest that plants using the various manufacturers' equipment be given a more general distribution of instruction sheets covering their methods of applying linings and making adjustments, and any other data which will assist in the selection and maintenance of brakes.

J. H. Miller: I would like to bring up an old question that every now and then comes to the fore, that of cast iron versus cast steel wheels. Also, I often hear the question asked, why we don't use a cast shoe directly against a cast steel wheel, such as is used in trolley service?

R. W. Graham: Mr. Lillquist did not mention the fact that we are using a-c rectifiers for brakes on conveyor belts and other almost continuous operating drives. I would like to have an expression from him on the applications of this rectified a-c brake against the motor operated brake. Why do they use a motor driven brake twentyfour hours a day when the same thing can be accomplished with a stationary a-c rectified brake? We have a few of these a-c selenium rectified brakes and their performance has been very satisfactory.

Another question I would like to ask Mr. Lillquist: What are the particular limiting or determining factors that govern the choice of series or shunt wound brakes on ore unloaders and ore bridge hoists? We have many control builders, who say, "We will give you either series or shunt brakes."

A. E. Lillquist: Referring to Mr. Graham's comments first, rectifiers are used in conjunction with brakes, as I mentioned, but at the present time it is quite often difficult to get good delivery on rectifiers. For that reason we have had to put off the use of rectifiers in many instances. When they are more readily available, they will probably be used more extensively.

Series brakes are designed to pick up on 40 per cent full load motor current and hold down to 10 per cent. In connection with the holding and closing lines on bucket hoists, quite often less than 40 per cent current is available for release. As a matter of fact, the current in many cases is somewhere around 20 per cent full load motor current. Brakes can be designed to release on 20 per cent full load motor current, but frankly they usually are a little too sluggish for the application. A brake designed to release on 20 per cent full load motor current usually requires a large magnet structure and this results in greater inductance and therefore more sluggish operation. For that reason a shunt brake with a very low voltage coil and a protecting resistance cut in after the brake is released often answers the purpose more satisfactorily. The time of release of the shunt brake compares favorably with the time of release of a series brake when called upon to release on 40 per cent full load motor current.

Mr. Dimitt's comments on actual field experiences with brakes are a worthy addition to the paper under discussion. Sometimes trouble is encountered because of paint on the pivot pins, and, as mentioned by Mr. Dimitt, this can be prevented by covering the exposed portion of the pins with protecting tubes. We are now using that arrangement as standard on one type of brake. Sometimes sticking of the pivot pins in the base is due to improper mounting surfaces. The surfaces on which the four base pads rest may not be in the same plane. This results in twisting of the base and improper alignment of the pins, thus causing binding between the pins and the pin holes. Shimming or raising the base by means of adjusting screws quite often aggravates this condition, particularly if the work is not carefully done. It is better to be sure that the mounting surfaces are in the same plane before installing the brake.

Brake wheels are usually coated with a rust preventive compound. Slushing compounds of the type used on wheel and pulley bores and on gears are not satisfactory, because they cause poor coefficients of friction between wheel and lining. We use a rust preventive which will not interfere with brake performance if the user forgets to clean off the wheel surface before placing the brakes in service.

Mr. Miller raised the question of cast iron brake shoes on cast steel wheels. The chief reason for not using cast iron brake shoes against steel wheels is that the coefficient of friction is too variable and is also quite low. Furthermore, I believe the service in industrial brakes is much too severe. Cast iron would be picked up on the steel wheel and welding action might result.

Mr. Leitch discussed the question of series coils in some detail and his comments were very worthwhile. Series coils are usually rated on the time cycle or time basis of the motor with which they are used. However, if the job is overmotored, it is necessary to take that fact into account when selecting or designing the brake coils.

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by B. B. FROST

ARTHUR G. McKEE COMPANY

CLEVELAND, OHIO

▲ THE purpose of this paper is to present operating data on new large hot blast stoves showing the performance that can be expected at various rates of blowing and various blast temperatures, and also to point out certain fundamentals of stove application as to number of stoves, total heating surface and brick mass required.

The blast furnace stove does not lend itself to easy calculation of heat transfer and storage possibilities, due to the variable and complex changes which are continually taking place. Methods of calculation have been presented and are used to some extent, but in most cases the size of stoves is dictated by many requirements other than actual heat transfer. These include size of checker opening (which is determined by the cleanliness of the gas available), minimum brick thickness (usually arbitrarily set by the operators in accordance with previous practice), size of existing stove shells if a new lining is the question, and space available if new stoves are being considered. If the size of checker opening, minimum brick thickness, and size of stove shell are arbitrarily set, the designer has practically no leeway in designing for the thermal requirements of the job. His only freedom is in actual brick shape and structural design, and in most cases the brick shape is dictated by the classification of special shapes and the resultant percentage above base price. In other words, in the design of stoves, which are basically pieces of heat transfer equipment, the subject of heat transfer takes a secondary place. Agreed that these other factors, based on required continuity of operation and the long experience of operators, are fundamentals which cannot be brushed aside in the interest of theoretical heat transfer advantages, yet it is true that more attention could be given the use to which the stove is to be put without jeopardizing the factor of reliability. In fact, the deterioration of brick work may be lessened by a more complete understanding of the thermal requirements of a stove. One of the factors often overlooked is the number of stoves and heating surface per stove. The following excerpt from A. L. Foell's paper, "Essential Consideration in the Design of Blast Furnaces", rather completely covers this point. He states:

"The number of stoves required for the operation of a furnace has long been a subject of controversy, and often rather fundamental concepts have been overlooked. The first of these is that the four-stove furnace plants have come down from the era during which dirty gas was used and frequent and regular shutdowns of one stove for cleaning were a necessity. The second is the fact that the total heating surface in a group of stoves used singly is not the determining factor. It is generally recognized that the maximum straight-line temperature available for any given blast volume is determined by the heating surface in one stove. If this statement is accepted at its face value, and it is assumed that the stove may be heated as rapidly as it is cooled,

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there is no reason why more than two stoves should be used. There are many practical considerations, however, that make three stoves necessary: (1) the time consumed in changing stoves, (2) the difficulties in burning gas at the rates necessary to fully heat the stove, and (3) the necessity for shutting down a stove for repairs. It would then appear that three stoves equipped with large burners and ample heating surface will satisfactorily take care of the furnace; and if one stove is down, the two remaining stoves would be adequate to operate the furnace at somewhat lower blast temperatures than the maximum available with three stoves. This, at first glance, might seem an insufficient margin of reserve capacity, but when it is considered that all new stove installations are predicated on straight-line blast temperatures of from 1400 to 1500 F and that most furnaces are operated on blast temperatures below 1200 F, the penalty when operating with two stoves is not likely to be very great.

"It is evident that the stove problem must be attacked primarily from the point of view of the performance capacities of a single stove and the ability to burn gas in that stove. With the present trend toward decreased stack temperature, increased blast temperature and the use of clean gas, it has become impossible to use brick thicknesses of 2½ and 3 in. and still maintain an economical balance between heating surface, brick mass and stove-shell dimensions. With the low stack temperatures and high blast temperature now demanded, it is necessary to reduce the average rate of heat transfer in a conventional stove to a figure below 10 Btu per sq ft per min. The ability to heat a given blast volume to a given straight-line temperature while maintaining a limited stack temperature in a stove is determined therefore by its heating surface, or by the rate of heat transfer, which is determined by the exposed surface and not by brick mass or its heat-storage capacity. It is, of course, necessary that an adequate usable brick mass be available with this heating surface, so that the stove shall be able to carry the required heat for some specified period of time. This being the case, the heating surface of a single stove determines the maximum straight-line blast temperature that can be carried by any number of stoves; the active brick mass determines the length of time the stove can stay on the furnace; and the size of burner, combustion chamber and stack auxiliaries determine the amount of gas that can be burned and the time required to heat the stove."

The ability to burn gas is not entirely a question of burner size as has been discovered by many operators. It is known that burner nozzle diameter is of primary importance in developing the full rating of large burners. No attempt will be made to cover the causes of burner pulsation and flash back, other than to point out that ample inlet nozzle and combustion chamber cross-section plus adequate chimney valves and stacks are essential. As the combustion chamber increases in size, more and more checker chamber volume is lost and unless a stove of large shell diameter is available it is impossible to obtain the required heating surface with high gas burning capacity. This one factor has, in many cases, been the only reason for using four stoves instead of three. It should be kept in mind, however, that if four stoves are used each one must have the heating surface needed to heat the blast and that the only advantage derived by the use of four stoves has been the reduction in required gas burning rate.

Again quoting Mr. Foell: "In order that brick mass may be useful, it must be close enough to some exposed brick surface to allow its stored heat to reach the surface before the surface temperature falls below the required point. This distance appears to be about 1 in. Brick farther than 1 in. from the heating surface cannot be heated and cooled during the ordinary stove cycle. From this standpoint, considering only a single stove, the thickness of checker brick should not be more than 2 in. if economical use is to be made of the brick. If we now consider a group of three stoves designed to burn an ample supply of gas, and provided with enough heating surface to assure reasonably low stack temperatures, the checker brick thickness should be materially less than 2 in. in order to obtain proper balance between heating surface, brick mass and maximum overall economy from the stove installation. Checker wall thicknesses of 1 to 1¼ in. are not uncommon in modern stoves. To obtain structural stability, the checkers must of necessity be laid up of special tile properly confined by a ring wall of stepped construction.

"Checkers with 2-in. to 2½ in. walls are in some instances considered necessary, in the belief that thin walls are more vulnerable than thicker ones to slagging and disintegration from alkalies in the blast furnace gas. Neither of these difficulties, however, can be remedied by merely increasing checker wall sizes. Slagging has been virtually eliminated by the fine cleaning of stove gas, and where alkaline conditions exist difficulties from this source are confined to the top 10 ft of checkers. It is, therefore, a question either of applying special or super-duty brick in this section of the checker chambers or occasionally replacing these checkers if failure from disintegration occurs."

TESTING METHOD

Having presented some of the theoretical considerations involved in stove performance, we will now turn to the actual operating results obtained on two sets of stoves. Experiments were made on two typical hot blast stove installations to determine the maximum duty that can be expected from one stove, both from the standpoint of blast heating and gas burning ability. The criterion of a hot stove was set at a 2000 F dome temperature or a 350 F stack temperature, and heating was stopped as soon as either of these temperatures was reached. These temperatures are considered conservative and are not necessarily the safe upper limit for either section of a stove. It may, at times, be necessary to exceed these temperatures in order to provide a particularly high blast temperature, but for the normal blast temperature of 1000-1200 F these limits are adequate. The stove used for the test was operated independently of the regular cycle set up for the furnace. That is, it was heated to the predetermined value of stack or dome temperature as rapidly as possible and then put on the furnace and allowed to stay on the furnace until the mixer valve was completely closed. It was then put on gas and reheated at the maximum burner capacity. As soon as the previously stipulated stack or dome temperatures were obtained, it was re-

turned to the furnace. These experiments were limited to the blast temperatures and wind volume being used on the particular furnace and for that reason tests were not available throughout the full range of blast temperatures or over a range of blast volume.

The furnaces and plants involved are not given by name but are listed by letter symbols. The stoves are of the nested checker type and the pertinent dimensions are listed in Table I. It will be noted that heating surface and brick mass are listed under two headings: "checkers only" and "total." The exposed brick surface of the stove dome and combustion chamber is equally effective in transferring heat and a brick mass to a depth of 1 in. behind this surface is available for heat storage. These added amounts of surface and brick weight are included in the column headed "Total surface and brick weight," and are used in making all calculations regarding the operation of these stoves.

DESCRIPTION OF STOVE EQUIPMENT

The two stoves tested were identical in cross section, both being 24 ft in diameter with 6 ft-11 in. diameter combustion chambers and a free area in the checkers of 100 sq ft. The stoves differed in the following dimensions:

	Plant A	Plant B
Stove height, ft	110	100
Checker height, ft-in.	90—1½	78—3
Heating surface, sq ft	219,500	191,000
Weight of checkers, lb	1,889,400	1,652,000
Burner rating, cfm	22,500	15,000
Burner fan volume, cfm	19,000	13,500

A typical cross section is shown in Figure 1 and a photograph of combustion chamber and top checkers in Figure 2.

The stove dome temperatures in both cases were obtained by bare chromel-alumel couples inserted in a special fire brick block located in the ring wall just above the top of the checker work (Figure 3). The accuracy of this method of dome temperature determination has been checked by the use of a platinum couple inserted through the dome plug and has been found to check closely. There are three methods commonly used for measuring the dome temperature of stoves; they are the radiation pyrometer, a couple in the ring wall brick work and a couple inserted through the dome plug. Of these three methods, it is believed that the radiation unit or the couple in the ring wall brick are the most indicative of actual top

Figure 1 — Typical cross-section of blast furnace showing lining.

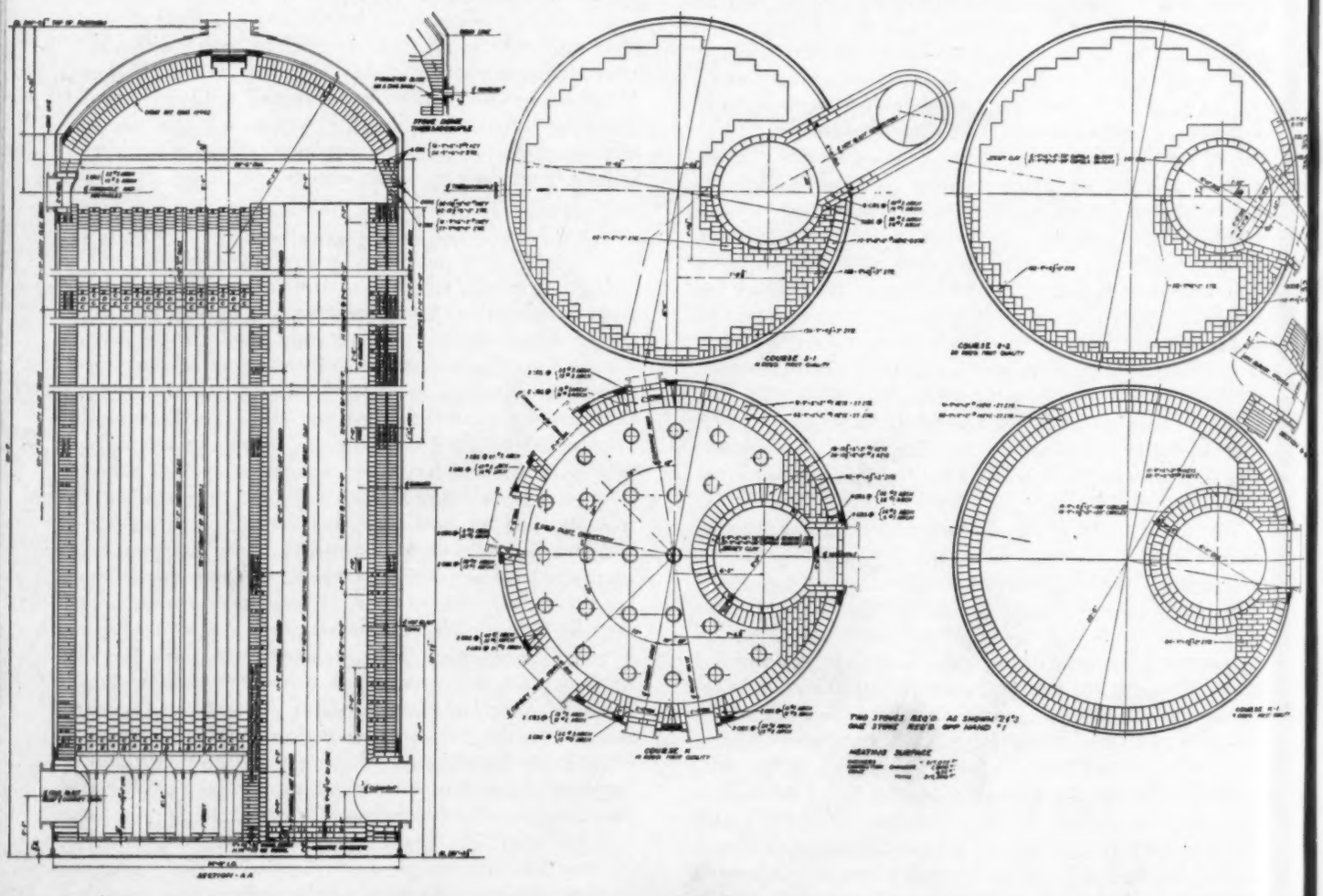


TABLE I

Principal Dimensions of Stoves

Description	Plant A	Plant B
Stove diameter, ft	24	24
Stove height, ft	110	100
Height of checkers, ft-in.	90—1½	78—3
Combustion chamber diameter, ft-in.	6—11	6—11
Combustion chamber area, sq ft	37.6	37.6
Burner nozzle diameter, in.	38	38
Number of chimney valves	2	2
Size of chimney valves, in.	45	45
Diameter of stack, ft	10	10
Height of stack, ft	200	200
*Heating surface in checkers, sq ft	217,075	188,400
Total heating surface, sq ft	219,500	191,000
Pounds of brick per sq ft of heating surface	8.57	8.57
Pounds of brick in checkers	1,864,168	1,625,000
Pounds of brick available for heat storage	1,889,400	1,652,500
Free area in checkers, sq ft	99.47	99.47
Checker opening, in.	1⅝ x 1⅝	1⅝ x 1⅝
Brick thickness, in.	1¼	1¼
Burner rating, cfm	22,500	15,000
Burner fan rating, cfm	19,000	13,500
Fan head, in H_2O	6	6

*This includes surface in cross passes.

checker and dome brick temperature. In many cases where couples are inserted through the dome plug, a sudden rise of 200 to 300 F is indicated when the stove is put on the furnace. This is accounted for by the fact that the stream of combustion gases has a low velocity through the space above the checkers and does not wipe against the dome brick and couple at the center of the dome. The conductivity of the couple is apparently great enough to reduce the hot junction temperature by the amount indicated because of the low conductivity of the protection tube. In the case of the radiation pyrometer, an attempt to read actual top checker temperature is made. These readings can, however, be seriously affected by any dirt in the flame, as these particles will either hide the checkers from the radiation unit which will in that case show the temperature of the particles in the flame, or if there are relatively few particles, they will tend to increase the temperature indicated.

Both plants were well supplied with recording and control instruments so that accurate data on all phases of stove operation were available. The rate of gas flow in each case was determined by a flow meter in the line and the readings corrected for the gas conditions existing at the time of the test. The burner regulation was checked at the setting used, which in each case was determined by the capacity of the burner fan — that is, the maximum air available from the fan was being used for combustion with a gas flow such that 1.5 per cent O_2 was present in the stack gases. The heating value of the gas was determined from a calorimeter in the blast furnace gas system. In both plants, the stove gas pressure was controlled at between 9 in. and 11 in. water gage. The volume of wind was in both instances measured by a venturi meter on the inlet side of a turbo blower.

DISCUSSION OF RESULTS

It will be noted in Table II that gas was not burned at the maximum rate during the whole heating cycle in some tests. The practice of heating for about ten minutes at 11,000 cfm was followed during periods when the combustion chamber was not considered hot enough to maintain combustion at high flow rates.

The low efficiency shown during No. 2 test at plant A is accounted for by the condition of the stove when heating was started. In this case the stove was on blast until the mixer valve was closed and allowed to stand over night before being reheated. During this period of 12 to 15 hours, a good deal of heat was lost by radiation. This heat loss had to be made up before the stove reached the predetermined dome temperature which established the end of the heating cycle. The heat thus lost is reflected in the low efficiency of 82.5 per cent.

During all the tests there were some changes in blast temperature or wind volume and sometimes both, resulting in inaccuracies due to lag of control and changes in hot blast main lining temperatures. On the whole, however, the results are indicative of the performance which may be expected from these stoves.

The figures which first attract attention are time on gas and time on the furnace. At plant A, with larger stoves and burners than at plant B, the heating time is very little over one half the cooling time, which is the reverse of usual stove practice. At plant B the time of heating, while less than the time of cooling, would leave only a little more than time to change stoves if two stove operation became necessary. It is apparent from these figures that two of the stoves at plant B

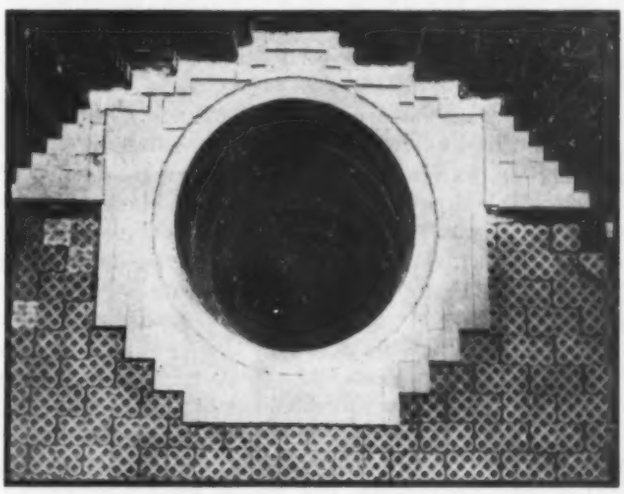


Figure 2 — View from top of stove, showing combustion chamber and top checkers.

could be relied on to heat 77,000 cfm of wind to 1150 F and maintain this cycle satisfactorily. It is entirely possible that a blast temperature of 1200 F could be maintained using two stoves if the burners were operated at maximum capacity at all times and no more than 10 minutes used for stove changes. If blast temperatures above 1200 F or rates of blowing above 77,000 cfm are required, it would be impossible to operate with only two stoves. The usual basic iron furnace, however, is normally run with blast temperatures below 1200 F.

At plant A, with larger stoves, the spread between time required for heating and cooling is even more marked. If the time required to change stoves is dis-

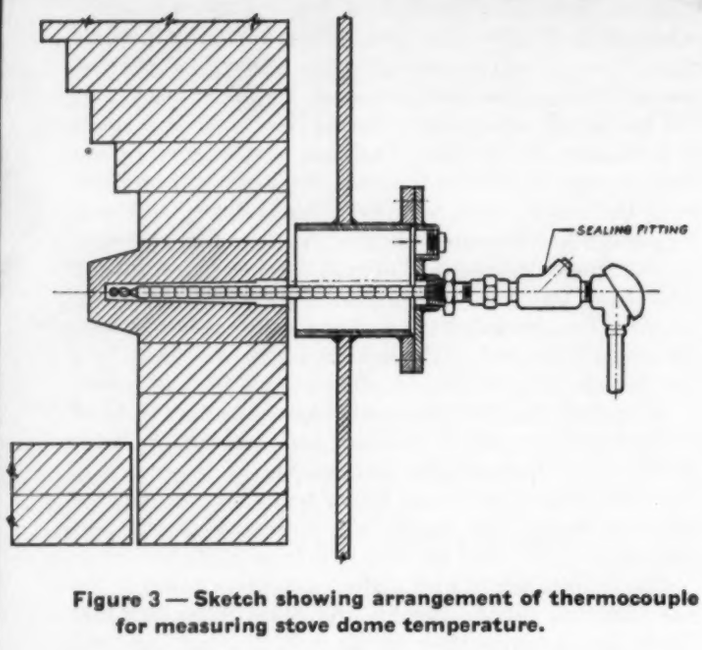


Figure 3 — Sketch showing arrangement of thermocouple for measuring stove dome temperature.

regarded and a stove efficiency of 85 per cent assumed, the heat available for blast heating at 23,800 cfm burning rate is 23,800 x .85 x 95=1,920,000 Btu per min. At 77,000 cfm wind, this is equal to 25 Btu per cu ft of air, which, based on a 200 F cold blast temperature, is equal to 27.5 Btu per cu ft above 60 F. This is equivalent to a blast temperature of 1500 F. This temperature, however, cannot be attained when using two stoves, because of the time required to change stoves. The effect of this lost time, which is a constant of about 10 minutes, varies with the heat storage capacity of the stove which, in turn, varies with the blast temperature to be carried. We know from experience with other stoves that a mean temperature drop in the brick of 400 degrees can be relied on when using a blast temperature of 1500 F with a maximum stack temperature of not over 400 F. This would allow a total heat storage of .275 x 400 x 1,889,400=208,000,000 Btu which could carry the furnace for 208,000,000 — (77,000 x 23) =118 minutes at 1400 F. If 10 minutes is allowed for stove changes this leaves 108 minutes for heating which will supply 212,000,000 Btu usable for blast heating. These figures indicate that when blowing 77,000 cfm a blast temperature of about 1400 F is possible when operating on two stoves. Again it must be remembered that the burners must be kept at maximum efficiency and the time for stove changing held to a minimum if such results are to be obtained.

The difference in maximum blast temperature available on two stove operation at the two plants is not fully accounted for by the difference in the gas burning rate. The difference in calorific value of the gas at the two plants, plus the difference in gas burning rate, amounts to a change of heat input of about 20 per cent, which is approximately the difference in heat content of 1200 F and 1400 F air. It is a mistake to assume that an increase of heating value of the gas can be utilized to increase the rate of heat input to the stoves, for as was noted previously the amount of gas burned is limited by the fan output. In other words, the rate of heat input is determined by the amount of oxygen available to burn carbon monoxide and hydrogen, so, regardless of the heating value of the gas, the actual heat release is controlled by the fan capacity at the particular pressure involved. The higher calorific value gas, however, produces a higher flame temperature, which gives higher dome temperatures, and the resulting advantage of a better heat transfer rate and increased stove efficiency. This factor is well illustrated in the results presented. Dome temperatures of 2000 F were obtained at plant A using 95 Btu gas with a maximum stack temperature slightly over 300 F, while at plant B a maximum stack of 350 F was reached before the dome temperature attained 2000 F when operating on 88 Btu gas. The effect of these temperature differences is also reflected in the stove efficiencies, although the difference in heating surface would also affect this factor in the same way.

Another factor affecting efficiency and overall stove performance is the cold blast temperature. This temperature sets the minimum brick temperature at the bottom of the stove, and of course thus sets the minimum stack temperature and stack losses. Therefore, a high cold blast temperature results in lowered stove efficiency if all other factors remain constant. The increased heat carried to the stove by the higher cold blast temperature does, however, reduce the heat storage and transfer requirements by that amount and to that extent is helpful.

The difference in efficiency of the two sets of stoves of about 3 per cent on the average may be caused by cumulative errors in data, but can also be accounted for by the points discussed above. To summarize, these points are greater heating surface and calorific value of gas, tending to increasing efficiency, and high cold blast temperature, tending to decrease efficiency of the stoves at plant A.

FACTORS INFLUENCING STOVE OPERATION

When considering new stoves, after a decision regarding heating surface and resulting brick mass has been made, the burner capacity and combustion chamber diameter must be set so that the stove will be capable of maximum performance. The size of combustion chamber, while highly important, is often given too little consideration, or if seriously considered, is modified to a great extent by the necessity of using an existing stove shell of too small a diameter. Actually the combustion chamber occupies a large percentage of the stove cross section and therefore limits the checker volume in any given shell and for that reason should be made as small as is consistent with the required gas burning rate. A gas burning rate of 400 cfm per sq ft of combustion chamber cross section has been considered the maximum for pulsation-free operation. In this case, however, a burning rate of 630 cfm per sq ft was used without trouble.

The question of stove heating is often considered solved by buying burners of ample capacity. This is not necessarily the case. Burners will pulsate and upset regulation for many reasons not under the control of the manufacturer. The trouble is usually blamed on the burner and many adjustments made without notable

TABLE II — Tabulation of Results

Plant	A	A	A	B	B
Time on gas, min	124	151	103	140	180
Average rate of gas burning, cfm	22,900	23,200	23,200	20,300	21,000
Maximum rate of gas burning, cfm	23,800	23,800	23,200	21,000	21,000
Heating value of gas, Btu per cu ft	98	95	99	88	88
Total heat input, Btu	278,800,000	334,100,000	236,500,000	249,920,000	333,000,000
Time on furnace, min	219	255	180	155	215
Average rate of blowing, cfm	77,000	72,890	77,500	77,000	77,000
Average hot blast temperature, F	1050	1038	1033	1150	1110
Average cold blast temperature, F	280	260	260	200	200
Heat output, Btu	248,000,000	275,900,000	206,200,000	209,200,000	287,000,000
Average stack temperature, F	277.5	287.5	265	300	300
Maximum stack temperature, F	315	325	290	350	350
Average stack loss, per cent	7	7.5	6.54	9.1	9.1
Radiation loss, per cent	4.1	10.0	5.21	7.4	4.9
Efficiency, per cent	88.9	82.5	87.25	84.0	86.0
Maximum dome temperature, F	2000	2000	2000	1900	1970
Minimum dome temperature, F	1370	1360	1360	1410	1420
Brick mass, lb	1,889,400	1,889,400	1,889,400	1,652,500	1,652,500
Sp. Ht. of brick, Btu per F, per lb	.275	.275	.275	.275	.275
Calculated mean temperature drop in brick work, F	476	530	396	460	631
Heating surface, sq ft	219,500	219,500	219,500	191,000	191,000
Heat transfer rate — Heating, Btu per sq ft per min	9.1	8.3	9.14	7.82	8.35
Heat transfer rate — Cooling, Btu per sq ft per min	5.2	4.95	5.22	7.05	7.00

success. It is of interest to point out that no pulsation took place during the tests shown above. The actual cause of pulsation and its cure was not studied on these stoves nor is a "cure-all" to be presented. It can be said, however, that certain steps were taken to prevent pulsation and that probably all of them had some effect. They are:

1. Large diameter of burner opening into combustion chamber — 38 in. in this case.
2. Flared burner connection.
3. A high head fan.

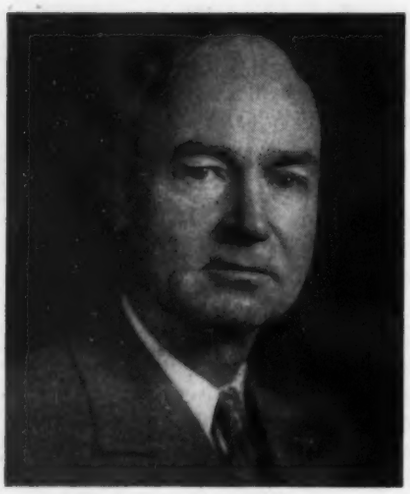
The first two items affect the gas velocity where the gas is being lighted and probably have an affect in preventing periodic flash back. The third item prevents a sudden change in combustion chamber pressure from material reductions in the volume of air delivered by the fan, as it is operating on a relatively steep portion of its head curve where pressure changes have very little effect on the volume of air delivered. This prevents an initial pressure impulse from starting a periodic pulsation which is self sustaining.

The free area in the checkers, stack valve size and stack height and diameter all have their effect on the back pressure of the stove and the performance of the burner. The back pressure in the combustion chamber of the stoves at plant A was 0.3 in. H_2O and the chimney valve pressure -0.2 in. H_2O, giving a total pressure drop on the stove of 0.5 in. H_2O. This low back pressure is thought to have helped in preventing burner pulsation.

Another factor influencing both stove efficiency and life of brick work which should not be overlooked by the operators is that a stove should be so heated that, if used on a fixed cycle, the mixer valve is completely closed when the stove is taken off the furnace. By doing this, the average dome temperature can be considerably reduced from the usual practice in stove operation. This point is well illustrated in the test data presented. The stoves at plant A were heated to a dome temperature of 2000 F, carried the heat demanded for over 3 hours, and finished the cycle with a closed mixer valve and a dome temperature of 1360 F. The average dome temperature was 1680 F. If this stove had been kept on the furnace only 1½ hours the lowest dome temperature would have been 1700 F, giving an average dome temperature of 1850 F. This higher average dome temperature would be reflected in higher temperatures throughout the checker work and as a result the stack temperature would rise rapidly during the heating period, resulting in lowered efficiency. It is obvious that a stove may be kept at an unnecessarily high heat head for any given blast temperature if the stove is not kept on the furnace until the mixer valve is closed. This method of stove operation is an inheritance from the time of aspirating burners and poor stove efficiency, when it was necessary to burn all the gas possible in order to have enough heat in the stove to provide a high blast temperature if needed. It is much simpler for a stove tender to keep his stoves too hot, so that any blast temperature desired is available, than to regulate the heating rate so that the mixer valve is closed when the stove has been heating the blast for some predetermined period. It is, however, detrimental to stove life and efficiency to allow this practice to be carried very far on modern stoves, which can be easily overheated. If the burners are large enough, changes in hot blast temperature can be easily taken care of by increasing the burning rate on the stoves being heated so that they will carry the desired blast temperature for the required length of time. This, of course, requires some planning in setting up the desired time cycle and the preparation of information for the stove tenders regarding the correct rate of heating and the maximum dome and stack temperatures required for various blast temperatures and rates of blowing. There are a number of instruments and meters which are used on modern stoves to provide the information for correct stove operation. These include:

(*Please turn to page 79*)

THE *Place* AND *Effect* OF *Conveyor Equipment* IN INDUSTRY



. . . . conveyor equipment has played a major role in the industrial development of the United States . . . . the steel industry is finding applications for some types of conveyors which were developed for other industries . . . .

by **J. E. McBRIDE,** VICE PRESIDENT
PALMER-BEE COMPANY
DETROIT, MICHIGAN

▲ IT would be rather presumptuous on the part of one not wholly connected with the manufacture of iron and steel to present a paper on how to convey materials in the iron and steel industry, on how materials are handled through all operations from the ore mines to the finished product at the mill, or how to improve your material handling equipment. The steel industry is already highly mechanized from beginning to end, for the most part by steel plant engineers, partly by the builders of auxiliary equipment.

The manufacture of steel being a basic industry now reaching close to 100,000,000 tons of ingots per year, the industry is dependent on many other industries for the nature, volume and market of its products. For this reason it seems pertinent here to review the development of the conveyor in other industries, the possible application of some of these developments to the steel mill, and the general effect of the conveyor on our political economy.

It is now an established fact that conveyor equipment contributes largely to reduce luxuries to necessities, to increase rather than decrease employment, to conserve human effort and strength, to relieve fatigue, and to add to general contentment and prosperity.

We recall that the forerunners of our present day industrial conveyors had their origin and development with the mass production and storage of grain, coal, cement and other loose materials. Immediately following the Civil War there was a great influx of capital and labor from the old world to the new. Industrial expansion started in this country on such a scale that the western plains were opened up to agriculture and eastern coal mines developed with a heretofore unheard of quantity production — grain to feed the rapidly increasing city populations, and coal to produce the steel and power for expanding industry. The invention of mechanical elevators and conveyors was mothered by necessity to make possible rapid and economical handling and storage of grain and coal. Here the background was made and foundations laid for future material handling methods in this country which have since become so widely known and world famous.

We are all familiar with the economic value of the reaper, the cotton gin, the mechanical coal cutter, and many other equally important inventions. Like the conveyor, these may have had the immediate effect of

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releasing men from employment, but their ultimate effect was to give employment to millions. When the reaper was first introduced, the revolt among those who made a living by the back breaking method of reaping grain by hand was very disturbing. Many machines were destroyed in the fields by those who really believed that this invention would take from them their only means of making a living. We later came to know that the mechanical harvester, together with many other agricultural implements, not only vastly increased the army of farm labor but also keeps employed thousands of men in factories making this equipment, and the same is true of the conveyor industry.

Thus we see how so-called labor saving devices, in which conveyor equipment has played a major role, have been a dominating factor in the development of the United States into a combined agricultural and industrial nation on a grand scale, where the "more abundant life" has been realized beyond any other part of the world.

In the field of factory and mill production, conveyor equipment begins to have a far greater personal effect than it had in agriculture and mining, and its accomplishments are far reaching. In this field there are advantages to both employer and employee of great importance. These may be listed as follows:

For the employer it provides:

1. *A great saving in floor space* — In the automotive and many other industries the combination of specially designed conveyors and mechanical operations has reduced the average area of floor space required to one-fourth that of a few years ago — in many cases to one-tenth.

2. *Increased output per man* — While the original conveyors were undoubtedly adopted to effect a saving in floor space, it was quickly observed that the output per man was greatly increased. Bringing the work to the workman and taking it away without an effort on his part automatically increased his output.

3. *Means of transportation* — The transportation of materials within a factory of large production has now become of prime importance to the management. Volume, speed, economy of room and lack of damage to materials are some of the results obtained which warranted this change.

4. *Reduction of inventory* — In the automotive field it was common sight in former days to see thousands of feet of manufacturing area literally choked with half finished work waiting for parts or to be painted, acres of space used for the air drying of paint, and for storing parts until some means could be used to move them along. The coordination of conveyors through every process and department, including painting, subassembly and connecting to the final assembly line, has cut inventories in two several times.

5. *Management can predetermine a day's output* — Assembly lines are built to operate at a predetermined speed. The conveyor is designed to carry the product distributed in equal spaces. By a simple calculation in the morning, any executive can know what the day's production will be, providing his supply of raw material does not fail or he does not have a strike.

6. *Neat and orderly appearance in factory* — "Show me a factory that is clean, neat and in perfect order every day, and I will show you a business success," said one of the greatest advocates of mass production with mechanical handling equipment.

7. *Fewer losses due to rejections* — In many cases production losses have been cut from 25 per cent to 2 per cent by the use of conveyors and continuous processes. These figures are conservative and are a matter of record.

8. *Better product* — Traveling quietly and quickly from one operation to another, without the hazard of manual handling, a better product is inevitable.

For the workman, the production conveyor conserves at least half of his energy by bringing the work to him and taking it away. His entire effort is productive. He is not too tired at the end of the day for

Figure 1 — Core drying conveyor in large production foundry, using drop-forged roller chain and roller-bearing trolleys.

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Figure 2 — Partial view of 8000 ft trolley conveyor carrying automobile motors from test blocks to final assembly.

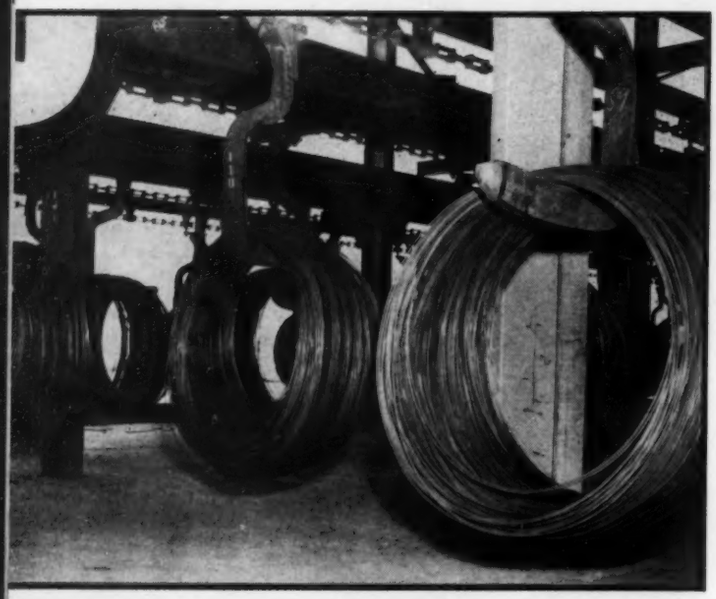
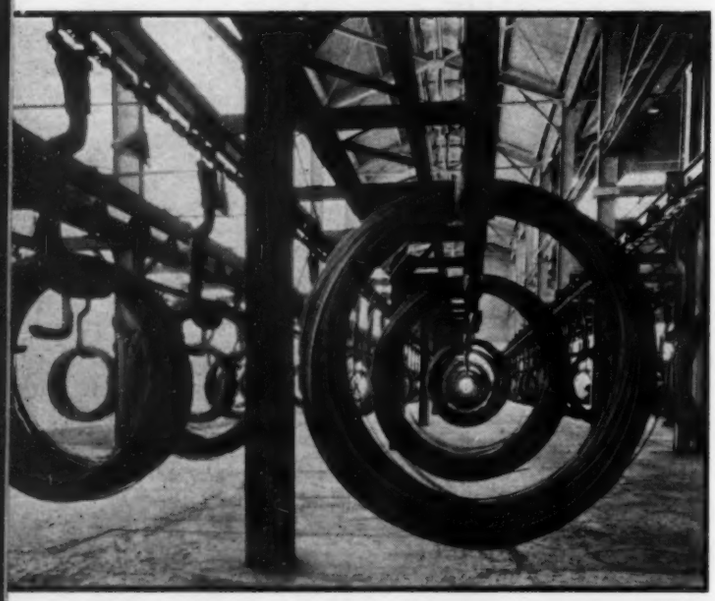


Figure 3 — A 1200 ft rod coil cooling conveyor made with heat treated rivetless chain and ball bearing trolleys.

Figure 4 — Another view showing five runs of overhead trolley conveyor for cooling rod coils.



recreation and he is fit for the next day's work. The Bible records that because he ate of the forbidden fruit, a curse was laid on man and he was told that from that time on he must earn his bread by the sweat of his brow. This curse is, however, year by year, becoming lighter. The inventive genius in this and other countries has largely been directed to taking the load off of our backs.

During the early twenties the manufacturers of automobiles were greatly worried about reaching the saturation point. Magazine articles and books had been written on the subject. During that time when this was a very live subject, I clearly remember a conversation where one of the group was a prominent automobile manufacturer. Someone asked him if he did not think the saturation point would very soon be reached. He abruptly answered, "No!". When asked what he based such a positive answer on, he replied, "People just won't walk." These four words gave the true answer to the problem upon which professors of economics in their books and articles could not agree.

It is not exactly a parallel case, but if I were asked if material handling equipment or any labor saving devices had reached the saturation point, I would paraphrase that other answer and say that, "People just won't sweat" — at least, not any more than they have to — while they work. Whether as a farmer, a factory or office worker, a housewife, a street cleaner or common laborer, we will press a button, shift a lever, or throw a switch, and mechanics or electronics will do the real work. Following the present war, the pent-up demand for labor saving appliances — for the home, the farm, the factory — from land, sea and air — will tax the productive capacity of this country. The manufacture of steel is a great basic industry that is largely the basis of our prosperity. The steel mills will be called upon to produce the enormous volume required for this peace time activity.

As stated before, the steel mill is already highly mechanized, and its product goes into all other industries. In these industries some types of conveyors have been developed for mass production, the principles of which are not frequently seen in the steel mill. It is my belief that, as the product of the steel mill expands to many new and many varied uses, new types of material handling equipment will be required.

First, I want to describe two types of conveyors that the iron and steel industry might use more extensively in the future; second, to suggest some improvements to roller conveyors, both gravity and power driven; third, to describe the modern hot coil conveyor for strip mills; and fourth, to illustrate material handling equipment in the steel and other industries.

THE OVERHEAD TROLLEY CONVEYOR

In the various industries there are approximately 600,000 feet of overhead trolley conveyor installed per year. The length of an individual conveyor is practically unlimited. In Flint, Michigan, there is an inter-plant conveyor 8,000 feet long, carrying a distributed load of 350 tons with one 5 hp drive. It occupies no ground or floor space, except at the terminals. In the Detroit area there is an inter-plant trolley conveyor 18,000 feet long (about 3½ miles of endless chain) with 26 drives, transporting in an endless stream a distributed average load of 675 tons at a speed of 40 feet per minute.

In an aviation parts plant in New Jersey, a 7,000 foot dispatch storage conveyor with seven drives services 23 stations where the parts are processed through all operations such as degreasing, normalizing, heat treating, all machining operations, and assembly. This conveyor receives and dispatches its trolley load at any one of 23 stations representing all of the main departments of the plant. Each station for each department has one man responsible for the operation of the conveyor at that point. He can send or receive a oad to or from any one of the other departments by means of station selectors set by the dispatcher. It keeps mass production going at a steady pace and practically all inventory off the floor and in motion.

It is my belief that the overhead trolley and chain conveyor will replace the cable installations formerly

Figure 5 — Carry-all conveyor for production, storage and shipment of washing machines. Conveyor operates in both horizontal and vertical planes.

used in steel mills. Already a length of about 1200 feet has been in use in a California wire mill for several years carrying coils of wire.

The trolley conveyor can operate at a speed up to 100 fpm. Individual trolley capacity varies from a few pounds up to 4,000 pounds and can be increased if necessary. Loads are hung from the trolley by means of hooks and trays or by metal baskets or buckets made to suit conditions and designed to load and unload automatically.

Every foot throughout the entire length of the trolley conveyor can be utilized if convenient, unlike the belt or slat conveyor which runs in one plane only and where one-half of the conveyor is unusable during its return, except in rare cases.

The trolley conveyor can make any number of turns, dips or rises in both the horizontal and vertical planes. This is done by means of traction wheels or a bank of stationary rollers for horizontal turns, and by means of large radius curves in the track for the vertical turns, either up or down. The drive may be either by a sprocket at some horizontal turn or by a caterpillar located on a straight run.

This conveyor can operate in oven heat up to about 600 F. Multiple drives are accomplished by use of high slip motors with about 15 per cent slip. The conveyor chain is usually drop forged of alloy steel heat treated to about 300 Brinell, is made in light, medium and heavy sizes, and can handle any load of compact proportions that can readily be hung on hooks or carried in trays.

This type of conveyor readily lends itself not only for the transportation of materials, but for processing through cleaning, painting, drying, bonderizing, annealing, and assembling. This conveyor is not extensively used by the iron and steel engineers, but I believe it will find a prominent place in certain developments of the iron and steel industry.

THE FLOOR TYPE CARRY-ALL

The floor type carry-all is essentially the trolley conveyor inverted. It is intended to run on the floor instead of being suspended overhead. It operates in both horizontal and vertical planes and is used to carry loads not suitable for suspension. This conveyor consists of four-wheel trucks or cars suitably spaced and made integral with a chain of a size and pitch suitable for the work to be done. On account of its great load carrying

Figure 6 — Roller conveyor with power chain in the center for conveying coils from the end of a continuous pickler to the cold mill.

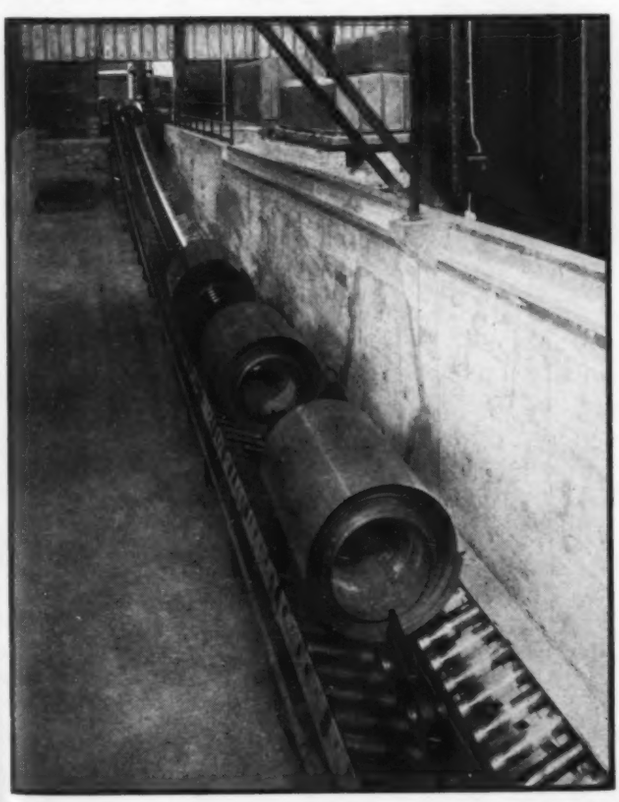
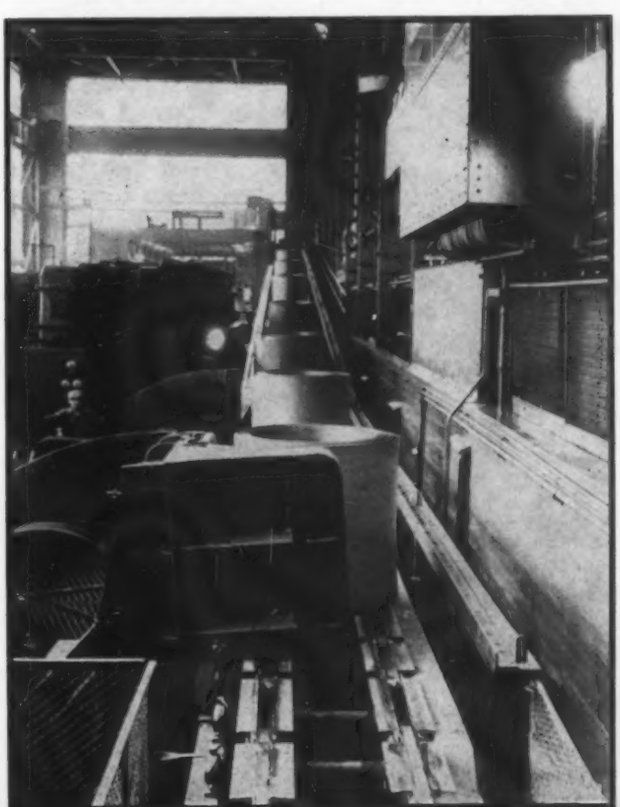


Figure 7 — A hot coil conveyor consisting of long pitched chains supported by flanged drums operating in roller bearings.



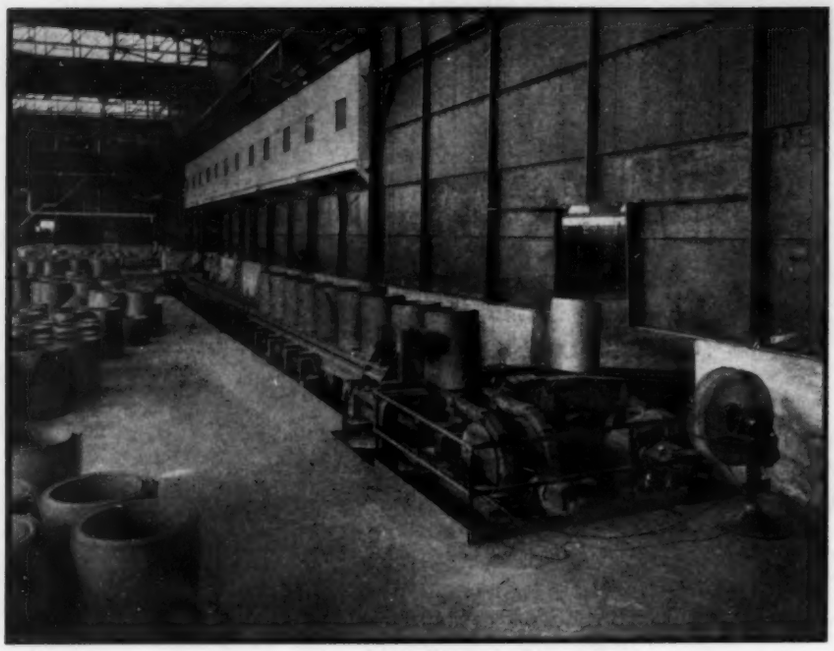


Figure 8 — Right angle transfer for hot coil conveyor.

capacity, which is almost unlimited, and the length and direction to which it can be built, its possible use in the steel industry can be quite extensive.

An installation using this type of conveyor has been made in the steel industry with individual truck or car loads of 15 tons each and a total distributed load of 1800 tons over a total length of 720 feet.

IMPROVEMENTS TO ROLLER CONVEYORS

Roller conveyors in many forms have been used in the processing of steel and non-ferrous metals. In recent years the loads to be carried (in the shape of coils and packs of strip and plate) are becoming heavier and heavier. Roller conveyor equipment, either chain or belt driven, and gravity types are now designed to withstand both the dead load and the shock load which occurs during loading and unloading by crane.

The best answer to heavy load and shock seems to be increased shaft diameter, increased roll diameter and wall thickness, the use of precision bearings with large load capacity, and the use of shock absorbers in the supporting sub-structure. Some methods for doing this will be discussed later. In this manner, single roll capacity has been increased up to 30,000 lb.

Precision bearings, besides having greater capacity, give better control of movement on inclines with varying loads and will start and run on less pitch than on commercial bearings.

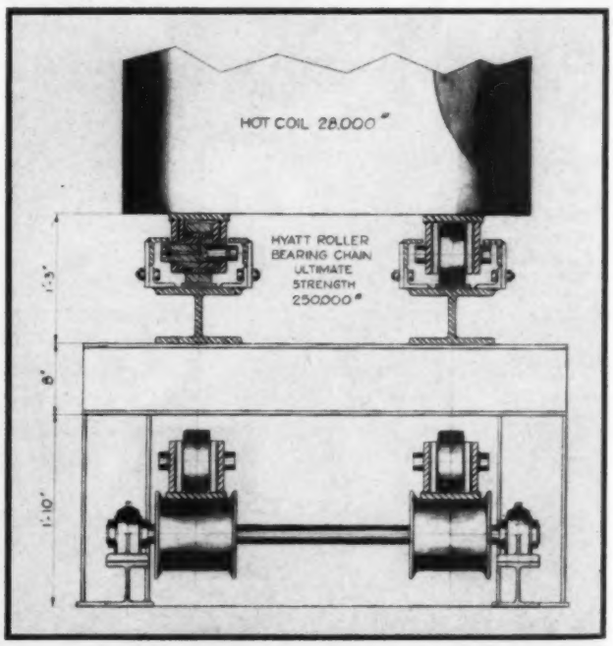
THE HOT COIL CONVEYOR

We have noted that mass production, as we are familiar with that expression today, had its origin in the automotive industry. To meet the demands of the automotive and other industries, using light gauge sheets, the steel mills had to resort to mass production of strip. The advent and development of the continuous wide strip mill, with its great production capacity, brought with it a major material handling problem.

The hot coil conveyors formerly used consisted of two heavy block type chains sliding on greased tracks with the coils sitting directly on top of the chains. These conveyors were comparatively short and were intended only to get the coils away from the coiler to a point where they could be handled by a crane.

Under the new conditions with coils of greater weight, greater width and greater quantity, and with greater transportation distances, an entirely new type of conveyor had to be designed and developed to permit a travel up to 1000 feet from coiler to coil storage. While the hot coil conveyor is used chiefly for transportation,

Figure 9 — Coil conveyor cross-section with rollers and anti-friction bearings combined into the chain construction.



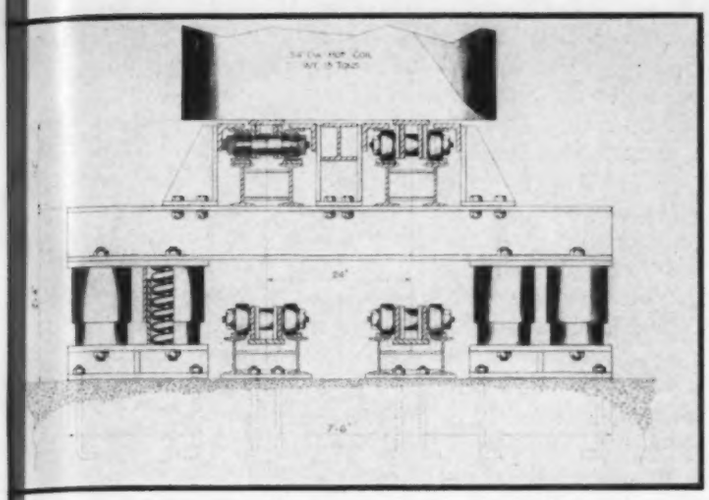


Figure 10 — Coil conveyor cross-section with anti-friction outboard roller chain construction and shock absorbing supports.

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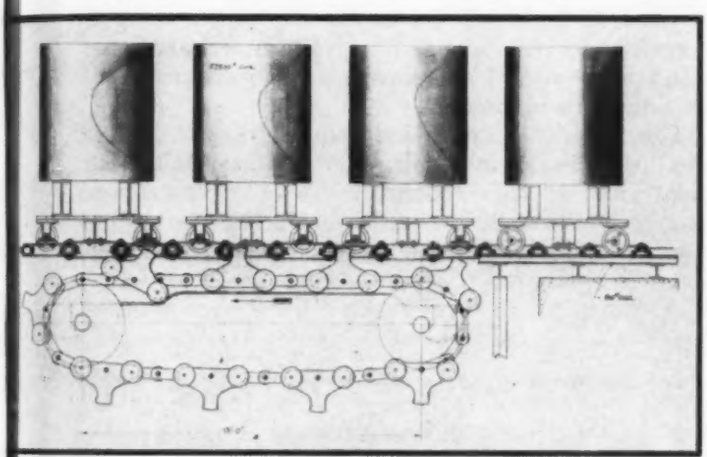
Figure 11 — This carry-all type of conveyor, with caterpillar drive, operates in the shape of a long narrow loop.



it has the added advantage that the coils may be measured for width and gauge while on the conveyor, and cooled while in transit for better and safer handling and for preventing distortion.

The design of the hot coil conveyor must provide for automatic loading at the receiving point, which is at the downender from the coiler. It must provide automatic 90 degree or 180 degree transfer from one conveyor to another. It must provide for automatic weighing and recording the weight of the coils while on the conveyor. It must guard against damage to coils in transit and should prevent their becoming smeared with grease. It should reduce manual operations to a minimum, if for no other reason than because of the intense heat. It should be rugged, with a minimum liability of break down, for it is the vital life line between the hot mill and coil storage. It should have an excess factor of safety to withstand shock due to loading at the receiving end and due to the impact of the magnet at the unloading end. It must provide for a capacity of from 100 to 120 coils per hour.

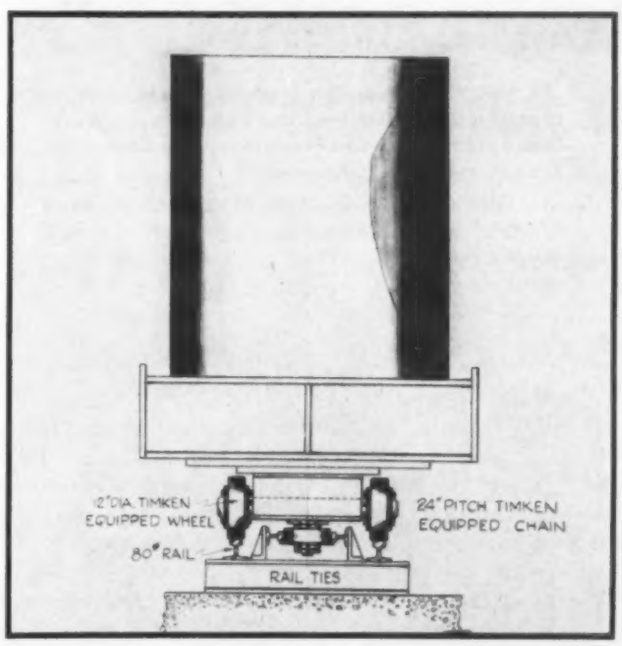
These specifications of design are very important. Today the hot coil conveyor must handle coils in widths up to about 100 in. and in weights up to about 15 tons at temperatures of about 1200 F, resulting in loads up to about 5000 lb per lineal foot of conveyor. It may be of interest to know that the hot coil conveyor at its maximum capacity carries a load per foot three times greater than the average fully loaded freight train per foot.

Like any other machine the hot coil conveyor has been developed through a number of stages in which "trial and error" and "survival of the fittest" have played a part. In this development advantage has been taken of alloy steels, heat treatment and precision bearings to provide strength, durability, smooth running, long travel, resistance to shock and saving of power. These conditions have all been met in a design now in operation in several mills.

The answer to this major material handling problem, as far as it has been reached today, is the result of the combined efforts of the steel mill engineers and the conveyor manufacturers' engineers. In my opinion the best solution could not have been reached by either one without the help and cooperation of the other. One with years of experience in connection with his own mill and with his operating department knows what to accept and what to reject and is able to offer many practical and constructive ideas. The other, with his years of experience in designing and selling his product, brings to his clientele the best available design and what is new in the industry.

I cannot bring this paper to a close without reference to the part the conveyor industry has played, and is playing, in war production. The man-hours it has saved in the endless stream of tanks, planes, war trucks, bombs, shells, small arms and hundreds of other items cannot even be estimated. In addition to the many million dollars worth of guns, gun mounts, bombs and radar equipment this industry has made for the government, it has delivered to Defense Plant Corporation

Figure 12 — Cross-section through carry-all coil conveyor designed for use where two parallel chains cannot be used.



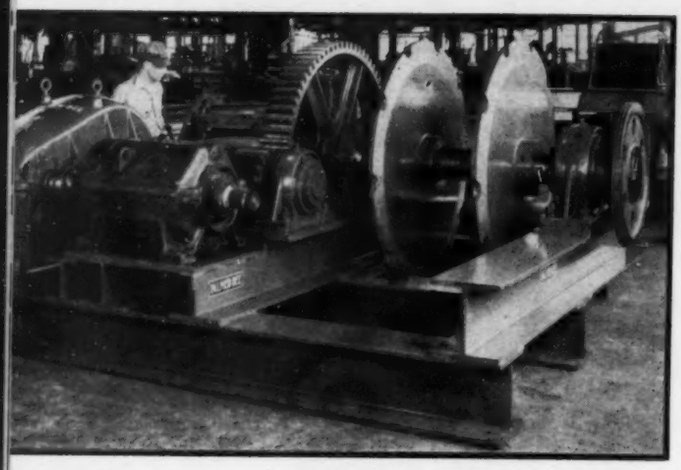


Figure 13 — Shop assembly of head shaft and drive mechanism for hot strip coil conveyor.

and privately owned war plants conveyor equipment valued at $75,000,000 in 1942, $75,000,000 in 1943 and $40,000,000 for the first half of 1944.

Tanks and half-tracks are assembled by conveyor lines 600 ft long; fighters and bombers on lines 1000 to 1500 ft long; war trucks and jeeps on equipment originally used for peace time automotive production. Sub-assemblies of thousands of parts are conveyed to the final lines in great volume and on time. The battle of production for the war effort has been won. Material handling equipment in the steel mill, in the foundry, in the factory, in the mines and in hundreds of other places has played a major role in this victory. To the very end it will play its part in the production of arms and armor that will bring victory in the field to us and our allies, and that will confound and destroy our enemies.

DISCUSSION

PRESENTED BY

R. W. MALLICK, Section Engineer, Headquarters Manufacturing Engineering Department, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

J. L. BUELL, JR., District Manager, Reliance Electric and Engineering Company, Detroit, Michigan.

J. E. McBRIDE, Vice President, Palmer-Bee Company, Detroit, Michigan.

R. W. Mallick: Mr. McBride's paper is very interesting and educational. It is especially timely, for I am sure that the next decade will find American industry more keenly interested in improving its material handling operations than any other common operation.

There are several points which will hear elaboration.

First — Material handling is one operation common to every industry and consumes more total labor effort than any other common operation. It constitutes the greatest single item of labor cost.

Second — Material handling adds to cost but nothing to the sales value of a product. It often causes reduction in quality, increases accident hazards, increases plant investment, and generally retards production.

Third — The best way to handle materials is not to handle them. We should first carefully engineer our plant layouts so that material handling is reduced to an absolute minimum. What handling is still necessary should be mechanized to the economic limits.

The accompanying illustrations show the application of a number of various types of conveyors to the material handling problems of production work.

We must constantly keep in mind that as we improve our methods and processes for forming, joining, processing and finishing the products of our plants, we usually reduce the skilled efforts put forth by operators and gradually tend to make them material handlers, machine attendants or inspectors.

This transition is taking place so rapidly in American industry under the principle of "division of labor," that it behooves us to take greater cognizance of material handling problems which, because of their magnitude, avoid perception. If we are to increase the productivity of labor to the levels our post-war planners claim is necessary to maintain and improve American living standards, we must of necessity apply increased engineering efforts in this field.

The material handling industries have provided us excellent equipment with which to mechanize our plants and thereby reduce this parasitic operation. They are also ready to provide engineering advice on equipment applications. To those of us who are responsi-

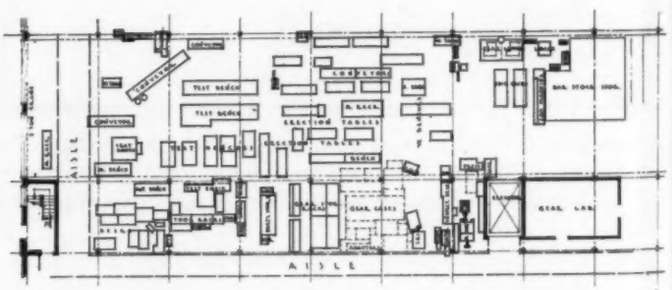


Figure 1 — Original layout of a motor assembly department, using no conveyors.

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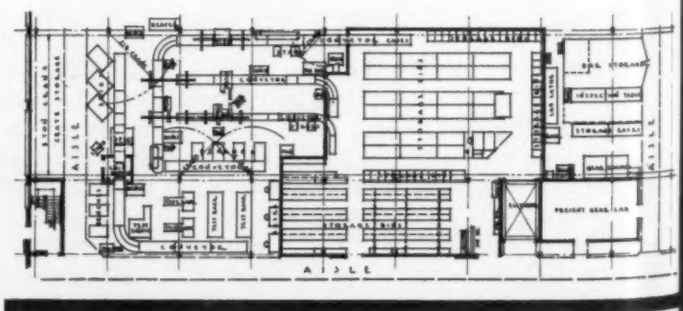
Figure 2 — This modified layout of a motor assembly department, fully conveyorized, increased production 47 per cent.



Figures 3 and 4 — Storeroom and shop ends of a roller conveyor.

ble for engineering our plant facilities and maintaining efficient operations, the challenge is ours.

J. L. Buell, Jr.: Mr. McBride mentioned multiple drives for conveyors, and perhaps I can present some additional comments on this subject.

Multiple drives are used primarily to reduce chain pull and thus permit the use of long conveyors or heavily loaded conveyors without excessive chain size. This is of special interest at the present time, as an added drive on an existing conveyor may possibly permit increased loading or greater length without having to replace the existing chain with heavier links. Incidentally, the use of two or more drives often results in a reduction in the total power used. However the total amount of power that is used on a conveyor is never very great.

Multiple drives can be of either constant or adjustable speed type. In the automobile plants the long overhead trolley conveyors that transfer material throughout the plants are often constant speed. The speed is set up for maximum flow and if production is lowered, they merely skip hooks — that is, when a piece is ready to go on a conveyor they hang it on the nearest hook and thus may leave several empty spaces between loads. Adjustable speed drives are used on production conveyors and on conveyors feeding to or from adjustable speed machinery.

The simplest type of multi-motor drive is one that depends on the electrical design characteristics of the driving motors for synchronization. Contrary to first thought, synchronous or fixed speed motors cannot be used on a multi-motor conveyor. A conveyor chain is made up of many links that are not all exactly alike. A sixteenth of an inch variation in a thousand links would make quite a difference in total length. Thus, there is not always the same number of links between two drives. Proving this point, conveyors have been built in the shape of an hour glass with two driving sprockets at the narrow section driven by one shaft. There was a case where there were two sprockets that were absolutely fixed together and the drives were not successful, the reason being that at one time a number of short lengths would be on one side of a drive and a little

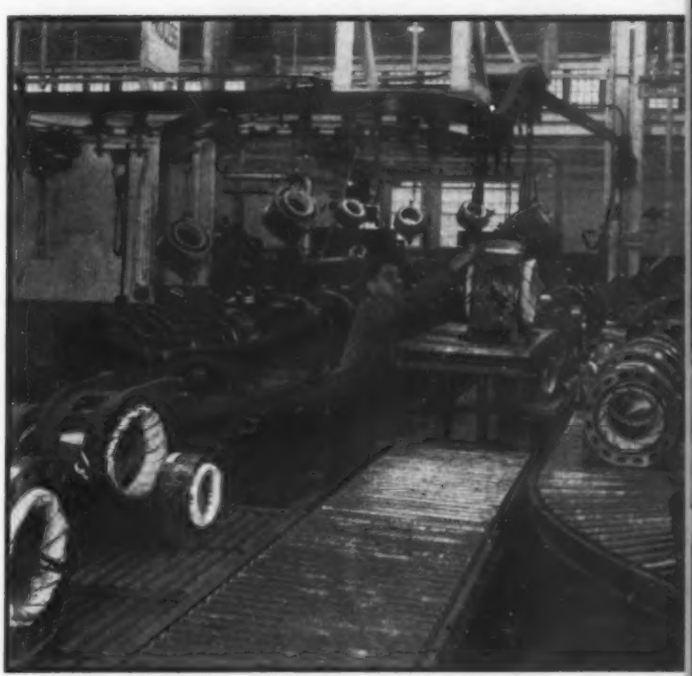


Figure 5 — Roller and overhead trolley conveyors are here used in combination to transport and process parts.

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Figure 6 — Belt conveyors may be used to carry materials between metal stamping operations.

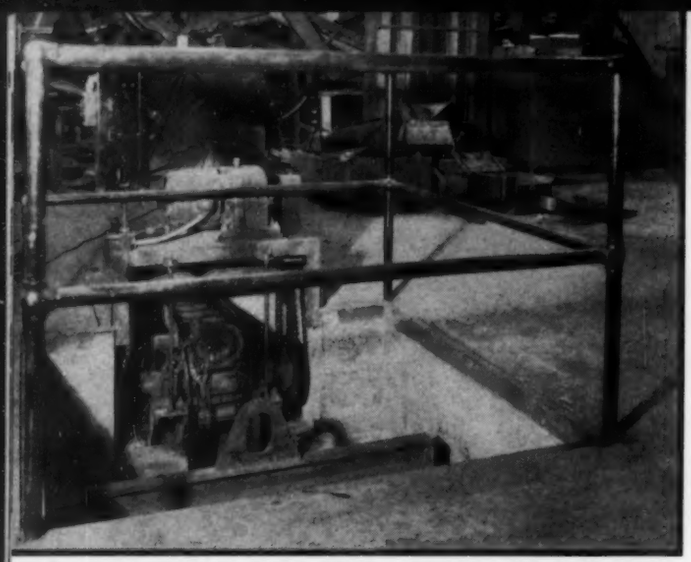

Figure 7 — This pan conveyor is used to remove scrap from stamping presses.

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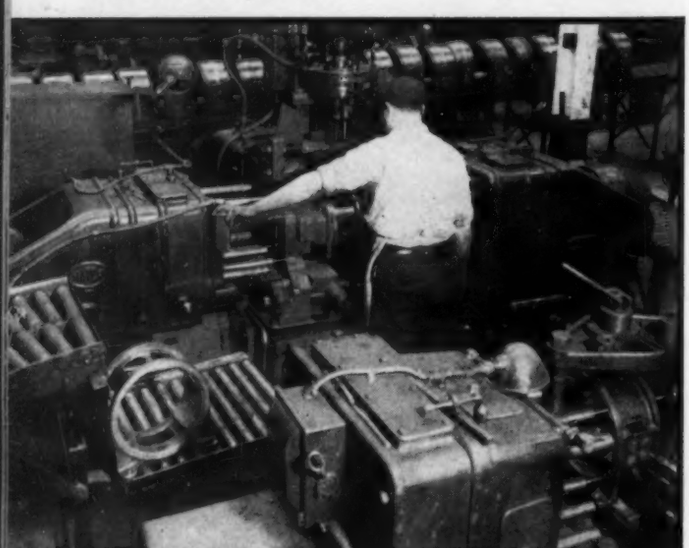
Figure 8 — A gravity roller conveyor is here used to bring material to the machine operator and to move it on to the next operation.



later they would be on the other, thus putting stresses in the chain and causing ruptures.

Further, the loading is subject to change. There is a case in one of the big automobile plants in Detroit in handling the engines of automobiles, where on Monday morning these engines are carried up to the sixth floor, and then on Friday afternoon the conveyor is empty and all of the load is being brought down. In other words, on Monday they have a very heavy lift load and on Friday they have a very heavy downhaul load, and during the week it would be changing all the time, so you can see one section could be heavily loaded at one time and lightly loaded at another. Another fact to consider is that these conveyors are often subjected to heat. In the automotive plants they often carry material through a drying oven and then out through a cooling yard. In a steel mill you may be handling hot coils which would cause a variation in your chain lengths due to expansion from heat of the links near the hot coils.

Therefore, the multi-motor drive must automatically compensate for varying conditions. In the electric drives this is done, as Mr. McBride mentioned, by using motors with a high slip characteristic — that is, motors with a wide variation between no-load and full-load speed. If the load increases on one section of the conveyor, the motor ahead of that section automatically slips or slows down slightly and the one ahead of it automatically picks up and shares the load. Conversely, if the load is lightened, the motor tends to speed up and thus helps the motor behind it. I like to think of these motors acting as if they had a spring behind them which automatically and instantly takes up a variation in load.

On constant speed drives, squirrel cage high slip motors are used, so designed and built as to have the same speed-torque curve. Their overload relays are connected so that, if one motor stops due to overload, all stop. This is the simplest type of drive. Incidentally, it is important that they do have the same speed-torque curve. Mr. McBride mentioned one plant in the Detroit area where they have twenty-six drives on one long conveyor. A funny thing happened on that particular job. At one time they had occasion to make some changes and they changed seven of these twenty-six motors, and when they replaced them they put in seven motors that were high slip but of a different characteristic and of a different manufacture than the original group. These seven motors promptly burned out and there was quite a little fuss about it. They said, "It is a very definite indication that these replacement motors are of poor manufacture because there were twenty-six in a row and seven of them burned out." That was not the case. Actually, those seven motors did not have as much slip as the others, and due to their not having this slip, they were attempting to carry the load of all twenty-six, and of course they did have trouble. So it is necessary on these multi-motor conveyors to have your motors all of the same speed-torque characteristic.

For adjustable speed multi-motor conveyors, the variable voltage system is used. A motor-generator set with exciter is used to supply power to all of the motors on the conveyor and the speed of all motors is varied together by controlling the voltage output of the main generator. It is accomplished by turning a rheostat that

Figure 9 — This view in a foundry shows a variety of material handling devices which minimize handling work.

Figure 10 — This conveyorized truck illustrates the possibilities of combining handling devices in specialized designs.

can be located at any convenient place. The motors are compound wound to give the high slip synchronizing ability mentioned for the constant speed drives.

Sometimes on these conveyors it is very necessary that the slack does not accumulate in the wrong place, and with variable voltage conveyors, through the use of the vernier rheostat for each drive, you can have one drive pull ahead of the others — that is, it doesn't actually pull ahead but it pulls harder and piles the slack in front of it.

The thought may come up as to the advisability of using two field control d-c motors on multi-motor conveyors in cases where you have direct current available. One such conveyor was built that I know of, and the speed control was obtained from two field rheostats mounted on a common shaft. It was not very successful and it has since been replaced, as it was difficult to match the rheostat; and furthermore, the two adjustable speed motors and control cost more than the variable voltage system of two smaller voltage control motors and their control unit.

Several hundred of the multi-motor drives are in successful operation in the automotive and other industries, and as long and heavier conveyors become more widely used in the steel industry there will very likely be a need for such drives.

J. E. McBride: I was more than pleased to hear Mr. Mallick's comments, for he spoke with the authority and experience of the plant engineer and user of material handling equipment. As a mass production and methods engineer he knows where the materials come from and where he wants them to go, and provides a layout with the least possible handling, and the least conveyor cost.

The arrangement and construction of buildings, and the nature of the product present different material handling problems in the various plants and industries.

I cannot emphasize too strongly the importance of conferences between the plant engineer and the conveyor manufacturers' engineer to determine the most effective and economical equipment for the desired purpose. It requires the experience and knowledge of the two combined to obtain the best results, and I think Mr. Mallick very clearly intended this procedure in his remarks.

Mr. Buell has very clearly elaborated on a point which I hoped would be brought out in the discussion — namely, the multi-motor drive for long and heavily loaded conveyors.

In mass production plants, the trend now runs to conveyors of great length. This is sometimes due to inter-plant distances, and more often to the modern desire to tie processing operations together in one conveyor unit with automatic or semi-automatic, selective pick-up and discharge. As I pointed out, they now vary in length up to 18,000 feet, which is not the limit by any means.

There is an economical limit to the size and strength of a conveyor chain, so that after a certain chain pull is reached each additional like amount requires another drive. This could be continued almost indefinitely.

I want to compliment Mr. Buell for explaining a most important point that has made possible a development for the wider use of a type of conveyor that may interest the engineers of the iron and steel industry.

FROST *Paper*

(Continued from page 69)

1. Dome temperature recorders.
2. Stack temperature recorders.
3. Combustion regulators.
4. Stove gas pressure regulators.
5. Stove gas flow meter.
6. Dome temperature controllers.

The first three are commonly used in all stove installations. The others are not in such general use at present. Of the other three items, the stove gas pressure regulator can be very useful in plants where the gas system pressure of necessity varies a good deal or where some users, such as boilers, are able to rob the rest of the plant. If, as has been pointed out earlier, well regulated rates of heat input to a stove are desirable, the easiest way to accomplish that result is to hold the pressure steady so that a burner valve setting, when made, can be relied on. The flowmeter merely provides an accurate means for indicating rate of heat input. The dome temperature controller provides an automatic means to reduce flame temperature by increasing the excess air delivered to the burner when stove domes reach some predetermined temperature. This control device can be very useful where high blast temperature is being carried and the stove dome is likely to be overheated if the required heat storage is to be utilized with a normal flame temperature. It is also helpful if high calorific value gas is being burned. If the cost and complications of this control is considered to be too great for its accomplishments, a stove dome alarm can be substituted.

A blast furnace stove is an expensive piece of equipment which can be seriously damaged by misuse and is worth protecting by well regulated operation both by automatic devices and intelligent supervision.

To summarize, the results of these tests definitely indicate two facts: First, that for normal basic iron production, no more than two properly designed stoves are required to insure reasonable blast temperatures. A third stove is, of course, required to insure continuity of operation. Second, that the blast heating ability of a group of stoves is determined by the heat storage and heat transfer capacity of one stove of the group and not by the total heating surface provided for the furnace.

Welding AND *Cutting* IN STEEL PLANT *Maintenance*

. . . . through the ingenious use of welding and cutting, maintenance men have been able to overcome shortages and shorten delays, thus keeping production at a maximum . . . . typical examples set forth here also show attractive economies . . . .

by **S. D. BAUMER,** ASSISTANT MANAGER
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▲ DURING the last several years the imperative need for maximum steel production has imposed upon mill maintenance departments new tasks and burdens which have brought home to all steel makers the possibilities of welding and oxyacetylene cutting in solving the all-important problems of plant maintenance.

Unlike many other types of industrial companies, steel mills have always been largely self-dependent in doing their own construction and repair work. But with the onset of the war, and increasingly as time went on, the mills were obliged to broaden the scope of this self-dependence even further, until today their maintenance programs are geared to cope with virtually any problem that may arise, regardless of whether it is an emergency or a routine matter. Many lessons can be drawn from this experience.

Due to the complete lack of replacement parts and the remote delivery dates quoted for replacement, maintenance departments have been forced to use every ounce of ingenuity at their command to minimize serious production delays and to prolong the life of already overworked equipment. In this work the welding and cutting processes have unquestionably contributed a large share. More important, however, is the fact that far greater progress has been made and more knowledge accumulated over the short span of the last few years than could possibly have been accomplished in many more years of normal operations. Much has been learned, for example, about the proper designing of assemblies to be welded, to give them the required structural strength and yet conserve on critical materials. Likewise, there has been a broadening of experience in the proper selection of welding materials and materials to be welded, both in the fabrication of new parts and in the reclamation of worn or broken parts.

Steel plant maintenance departments deserve a great deal more credit than they usually receive for their achievements in enabling the mills to set wartime production records. While welding, cutting, and the allied oxyacetylene processes have served as major tools to these organizations, it is chiefly because of their intelligent and enterprising application of these processes that progress has been made. This was done under the added handicap of shortage of skilled help and the consequent necessity to train new men and even women to replace those called into the armed forces.

In surveying the accomplishments of mill maintenance organizations it is unfortunate that in numerous

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cases it is impossible to obtain accurate and complete records. This is due partly to the lack of adequate help in the mills for recording such data, and partly because jobs were done as a matter of course without recognition of the fact that there may have been something out of the ordinary about them. This latter tendency is one reason why the dissemination of information about these operations often lags too far behind the original solution of these problems. However, the volume of information which is available is much greater than can be compressed into a single paper, and so in the following comments I will attempt to highlight the most important without devoting too much space to details.

Probably one of the most important maintenance processes in the steel mill is the application of hard-facing materials to parts subject to severe wear. Almost unlimited benefits can be derived from their use, provided the correct hard-facing material is selected and the proper technique of application is followed. In some cases there will be a choice between hard-surfacing and flame hardening as alternate means of prolonging the life of wearing parts. Each of these processes has its field in mill maintenance work.

SHEAR BLADES

A great deal of study and thought has been devoted to means of avoiding the costly delays, running from an hour or two to full mill shifts, caused by worn shear blades. One mill, for example, used a blade 4 × 12 × 54 inches, made of 70 to 80 carbon rail steel and used for shearing hot slabs measuring 4 to 8 × 51 × 72 inches. These blades normally lasted only three 8-hour shifts, shearing 3000 net tons of steel. It was decided to try a 45 to 50 carbon steel blade and to hard-surface one cutting edge with a non-ferrous cobalt-chromium-tungsten alloy which gives a deposit of 41 to 43 Rockwell hardness and retains high hardness even at red heat.

This blade was prepared by planing a groove about ½ by 1¼ inches on the cutting edge, as indicated in Figure 1. After preheating with coke oven gas to about 700 F, the hard-surfacing material was applied by the oxyacetylene method, and the blade left to cool slowly. On its first trial run in the mill it sheared 75,000 tons of steel and lasted for 62 shifts, as compared to three shifts for the straight carbon steel blade previously used. The total cost for labor, overhead and materials was about $12.

After the trial run, considerable scoring of the non-surfaced area of the blade was found, but this was overcome on the next rolling by applying a self-hardening weld deposit on this upper portion of the blade. The original deposit was worn down only ⅛ inch. It was evident at this time that several check cracks had developed, but these apparently had no bad effect upon the steel being cut nor upon the life of the blade itself. After restoring the edge metal worn away, the blade was put back into service a second time.

The flame hardening method for lengthening the life of mill shear blades was tried recently on a fast acting steam-hydraulic shear on a 40-inch blooming mill. This mill rolls its own blade stock, and selected SAE 4160 for this trial. After cutting and machining, the cost of the blade to the mill was about $35. All four edges of the blade were flame hardened and used for cutting edges. During a period of seven weeks this blade sheared 100,000 tons of steel of various grades before it was removed from the mill. Since the mill shears 8 x 8, 7 x 4, 6 x 4 and 5 x 4 inch billets, the shear is fast acting, and this speed, together with the fact that the billets are fairly long (up to 20 feet and longer), tends to prevent the hardness from being drawn out of the blade. This accounts for the selection of the less costly flame hardening process as against hard-surfacing. After the hardened blade becomes worn it is stress-relieved in a furnace, trued up and rehardened for future use.

ROLLER GUIDES

Another good example of increased life is the hard-surfacing of roller guides used in rolling 1¾ to 2½-inch rounds, etc. in 12-inch and 14-inch bar mills. These roller guides are mounted ahead of the mill rolls to keep the hot bar in alignment and to prevent scratching of the finished bar. Such scratching was very prevalent with the type of guide formerly used.

After numerous tests and trial runs to determine the best grade of material for hard-surfacing, the cobalt-chromium-tungsten alloy previously mentioned was selected because of the fact that it did not pick up scale from the bar being rolled, and also because it retained its hardness at elevated temperatures. This alloy was applied by the oxyacetylene method over the areas indicated in Figure 2. It was found that by preheating the base metal to 400-500 F minimum, pin-holing was completely eliminated. After welding, the guide rollers were ground down to finish size on a centerless grinder, leaving a final depth of deposit of ⅛ inch. The cost of the original work was approximately $75 for one set of six rollers.

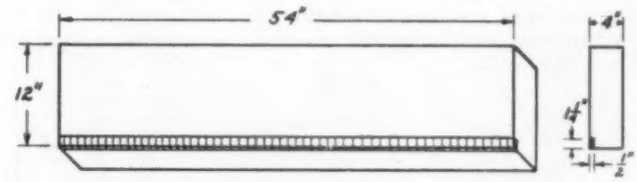
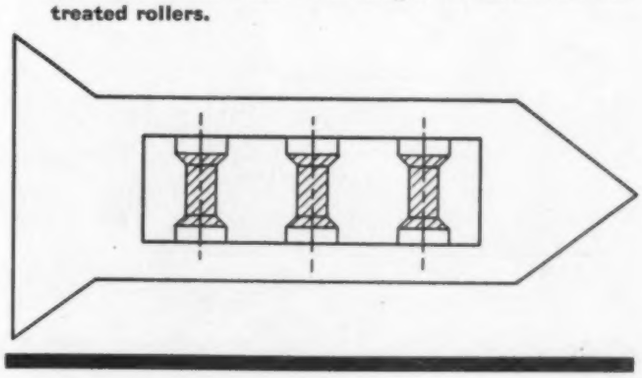


Figure 1 — Shear blade with planed groove filled with hard-surfacing weld metal, indicated by shading.

Figure 2 — Roller guides hard-surfaced on shaded areas give more than double the length of service of untreated rollers.



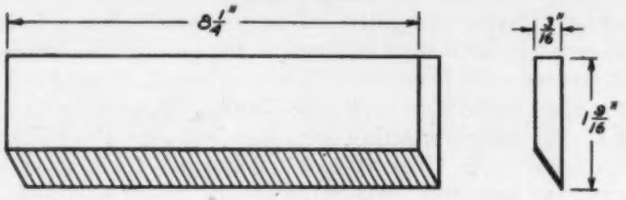


Figure 3 — Sulphate scraper blade with thin facing of hard-surfacing material increases life from 3 weeks to 12 weeks.

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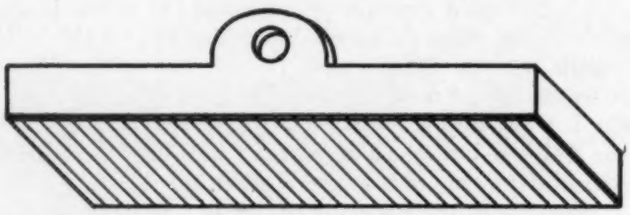
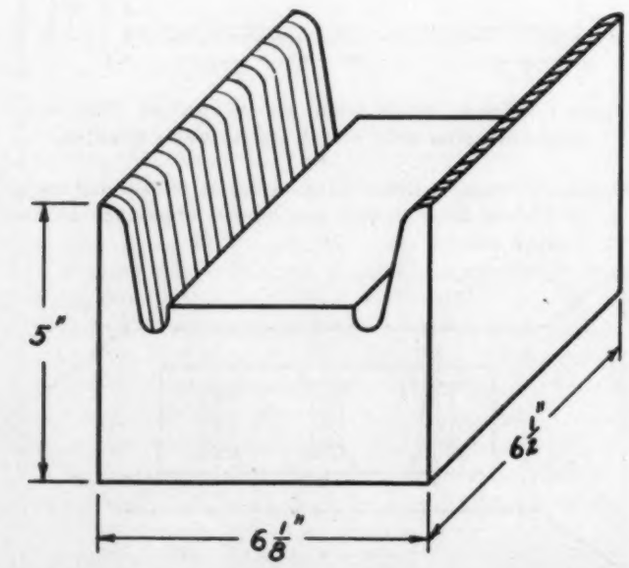
Figure 4 — Coke pusher shoes with entire bottom covered with a coated high-chromium, high-manganese rod. Service life is increased more than four times.



After installation, this particular set of guides was removed from the mill at intervals of 3000, 6000 and 10,000 tons, and the amount of wear noted. From these observations it is now evident that the tonnage that can be satisfactorily rolled without resurfacing will be approximately 15,000 tons or more. This is more than double the test run on other grades of hard-surfacing materials. We feel, however, that with further study and with closer attention being given to the adjustment of the guides themselves, even greater life can be obtained from this type of guide.

Figure 5 — Oxyacetylene flame hardening instead of carburizing reduced distortion and increased the life of this die box holder. Hardening process was applied on shaded areas.



SULPHATE SCRAPER BLADES

In most by-product coke plants the equipment for removing or cutting sulphate from the screens in sulphate dryers requires considerable maintenance. The scraper blades used are in some cases made from high chromium steel to avoid corrosion and to give longer life, and have a hardness of around 45 Rockwell C. Such blades cost as much as $100 apiece. After only three weeks of constant service these blades are generally unfit for further use.

Here again the trial and error method had to be followed to determine the most satisfactory means of reclaiming these blades and extending their service life. After several months of experimentation to avoid check cracks, warpage, etc., a method was found which gave nine weeks additional life to a blade previously ready for the scrap pile. Hard-surfacing material was applied by oxyacetylene welding as shown in Figure 3, covering the entire beveled surface of the blade with abrasion-resistant alloy.

Discounting the time for removal and reinstallation of the blades, which takes several hours, the cost for resurfacing a set of four blades is $1.50 each for materials, two hours of gas welding time per blade, and two hours for grinding, making a total of about $10 per blade or $40 per set. The reconditioned blades last three times as long as a new blade, and for the set of four the saving to the plant amounts to more than $360 every three weeks.

COKE PUSHER SHOES

Another coke plant maintenance operation is the hard-surfacing of coke oven pusher shoes. In normal service a flat type of shoe survives in service only seven days, since it is subjected to severe abrasion at high temperatures. It might be assumed that the type of alloy which proved best for surfacing mill guides would also solve this problem, since the operating conditions are so similar. This proved to be untrue, however, due to the slow motion and heavier loads imposed on the shoe. The most satisfactory results were obtained when the shoe was surfaced, as shown in Figure 4, with a coated high-chromium, high-manganese rod giving a deposit of 54-58 Rockwell hardness. Compared to the one-week life of the plain cast steel shoe, the resurfaced shoes generally give over thirty days service.

DIE BOX HOLDERS

In the splice bar department, one of the problems of wearing parts is the die box holders or punches which in this case are used for punching holes in 35 to 45 carbon steel bars. Six of these die boxes make up a set, and they were generally hardened by carburizing to a depth of .018 inch or thereabouts. This procedure would shrink the machine fits to the extent that the box itself was thrown out of shape. This necessitated eight hours of grinding and cleaning for the set of six, which, with the five hours carburizing time, brought the total to thirteen hours.

By using flame hardening in place of carburizing, neither grinding nor machining was necessary, due to the fact that only the wearing surfaces where the bar slides are hardened, the hardening being done after

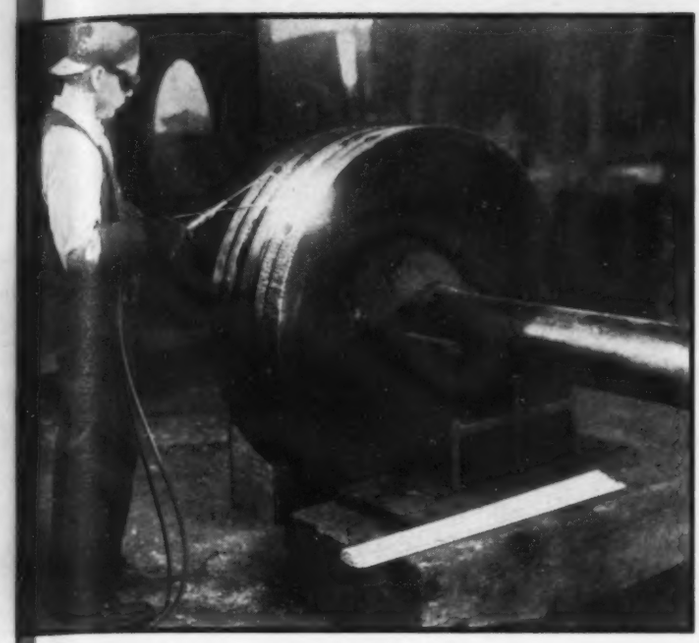


Figure 6 — Cast iron piston head from blooming mill engine being brazed over worn surface with manganese bronze. This operation trebles the life of mill cylinders before reboring is required.

←

the machining operations. Figure 5 shows the areas hardened by the oxyacetylene process. The degree of hardness produced was around 54-55 Rockwell C. This operation reduced the time from 13 hours to 2 hours, and produced a box which outlasted the carburized die box by about 40 per cent. Since the maintenance operation involves some time for setting and resetting the holders to hold necessary tolerances and alignment, this 40 per cent increase in life effected another saving in time and labor, since maintenance work need not be done so frequently.

CRANE TONG BITS

Most steel mills are confronted continually with the problem of wear on crane tong bits, which are used primarily for transferring hot steel from the soaking pits to the rolling mill tables. These tong bits, whether used on slabs, ingots or blooms, wear down rapidly, being normally made of any kind of steel from axle grade to the very high carbon steels. Such bits usually last only about 2½ hours before replacement is necessary.

Trials with all sorts of material, including high speed and semi-high speed tool steels, file steel and other grades, gave varying results. A test was then run using bits on which the entire point was built up with a cobalt-chromium-tungsten hard-facing alloy giving a deposit of about 54 Rockwell hardness. This was found to increase the service life of the bits approximately twenty times.

Some mills prefer single-prong bits and other five-prong, but either type can readily be hard-surfaced for longer life. The determination of which type to use depends upon what the manufacturer is looking for in the finished product and how much reduction is made on the finishing rolls.

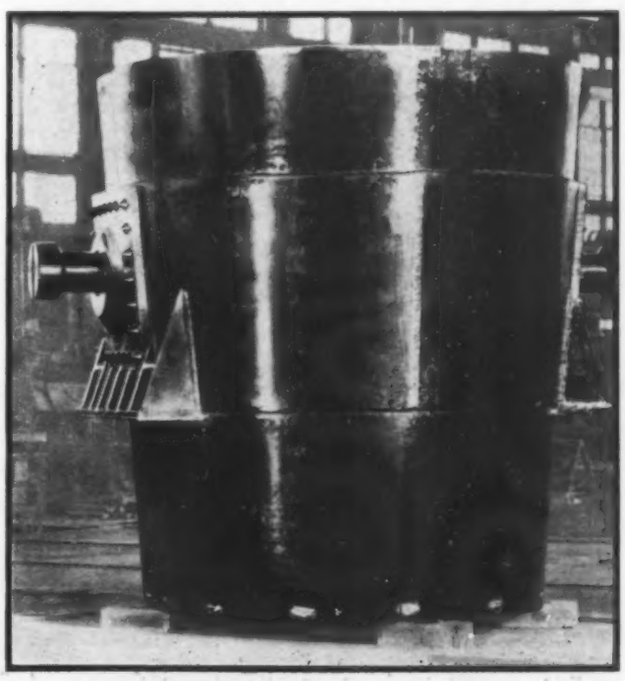
BUILDING UP WITH BRONZE

Bronze weld metal is sometimes most appropriate as a resurfacing material where it is desirable to confine the wear between two parts to the one part which is easiest to resurface or less costly to replace. A good illustration of this is the wear between a piston head and a cylinder. The piston can be more or less readily

Figure 7 — Cast bronze feedwater pump casing being built up on worn areas with bronze welding metal. Gas torch at right is used to drive off condensed moisture.

▲

Figure 8 — This 85-ton welded ladle, fabricated of parts shaped by standard flame cutting and bending equipment, is 20 per cent lighter than a riveted ladle, and can carry more load.



removed and the lower half of the sliding surface built up with bronze weld metal, as shown in Figure 6. The illustration shows the reclamation of a mill engine piston, but the same treatment with bronze is appropriate for pistons on switch engines, dinky engines, pumps, and other parts which are more easily accessible for repair than their mating parts.

Another operation on auxiliary mill equipment is illustrated in Figure 7. In this restoration job, all wearing parts of a feedwater pump were built up with aluminum bronze weld metal by the electric arc process. The pump casing was of cast bronze and the narrow bands of weld deposit were held to size by a bent copper strip fitted into the space between the bearing surfaces as shown. The diffusers and ring pieces were also built up and machined down to proper tolerances. Once again, this restoration by welding put a piece of essential mill equipment back in service when otherwise a long and costly delay might have occurred.

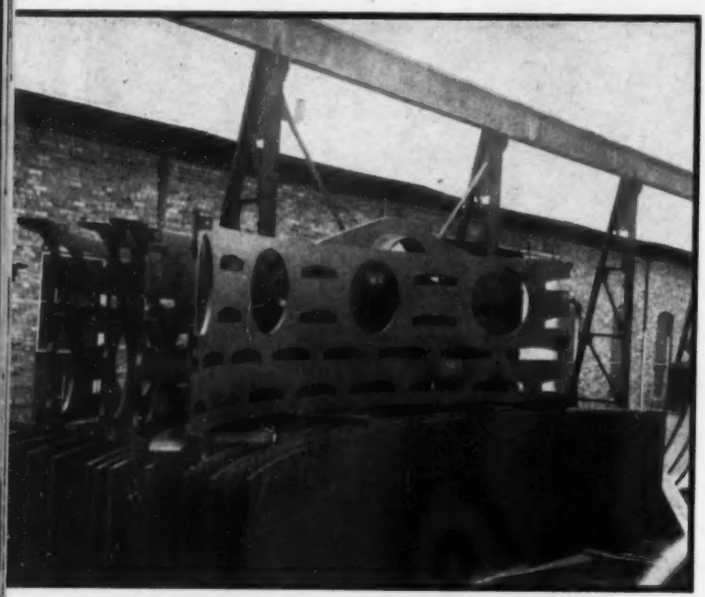
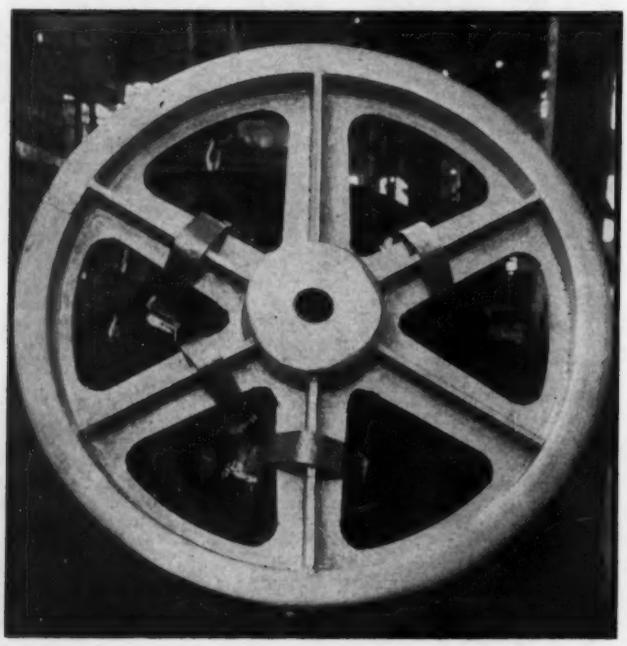


Figure 9 — Segments of tuyere jacket (top) and hearth jacket (bottom) made by oxyacetylene cutting and bending. Welded jackets can be erected in a few hours, instead of days as formerly.

▲

Figure 10 — To replace a broken cast gear, this large gear was fabricated in one week by welding. Such fabrications can readily be made on short notice.



FABRICATION OF REPLACEMENT PARTS

The fabrication of replacement parts by gas cutting and welding has been standard practice in most mill maintenance organizations for some years, varying and increasing only in the extent to which this department is relied on to provide such new parts, as against outside purchases. During the last few years steel mills have become almost entirely self-sufficient in this respect. The advantages inherent in welded fabrication are numerous, but even if we consider only its speed and flexibility it would still be a boon to all steelmakers.

The present trend in fabrication is toward the use of lighter sections. Wartime restrictions on the generous use of metal have brought about an increased awareness of the design of a welded fabrication, putting into practice the fact that no increase in section is necessary to compensate for reduced strength at the joints, since welded joints are as strong as the adjacent metal. Thinner plates are being used without sacrificing necessary strength and steel is thereby being conserved. Other advantages, often more important than steel conservation, may be secured through this reduction in weight of properly designed and balanced structures.

An example of this is the fabrication by welding of open hearth ladles. Here the reduction in weight of the welded ladle as compared to the riveted and cast ladle is approximately 20 per cent, which is important chiefly because it enables an 85-ton ladle such as shown in Figure 8 to carry an additional 15 tons of molten metal without taxing the capacity of the crane. Here the elimination of rivet holes permitted thinner plate to be used. The elimination of laps and butt straps also contributed to the saving in weight. Cost reduction, which may or may not be present, is hardly a factor in the decision to fabricate, since load gain is the decisive factor. The life of the welded ladle is equal to that of a riveted ladle, and the welded design has the added advantage of being more easily repaired in case of a spill. Instead of an overlapping patch, a piece of plate is flame-cut to fit and welded in.

TUYERE AND HEARTH JACKETS

Inasmuch as continued production of iron is necessary in holding steel production to the maximum needed in the war program, it has been necessary to devise ways of speeding up the restoration of blast furnaces when they are down for repairs. Two of the most outstanding operations which have reduced down-time for relining have been the design and fabrication of welded tuyere jackets and hearth jackets. Flame-cut parts for these jackets are shown in Figure 9. These two items, which normally required days of installation time, are now being installed in a matter of hours. Instead of having to drill rivet holes in the shop and spend considerable time aligning the sections in the field for riveting, the plates are beveled with the torch, set up in the

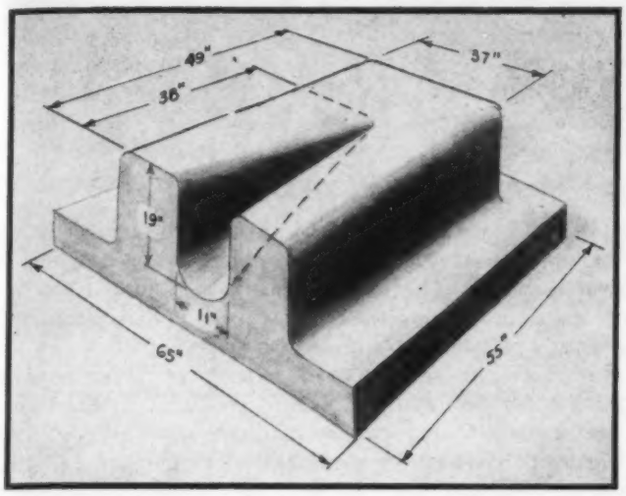


Figure 11 — Flame machining with an oxyacetylene scarfing torch saved a great deal of time in shaping this forging die when it was needed in a hurry.

shop and marked, then lowered into position in the field and welded.

GEAR AND GEAR BLANKS

The constant need for replacement gears of all sizes is another problem which is easily met by the maintenance department. Again, this is a task where speed is often paramount. The six-foot diameter gear wheel shown in Figure 10, for example, was fabricated in only one week to replace a cast gear which broke in service. A 4-inch thick rim was cut and bent to shape and welded at the joint. A solid disc web plate was then flame-cut with a center opening for the forged hub, and welded in with the 1½-inch thick rib stiffeners. The six windows were cut last, using a hand torch and guide bar, to avoid distortion. After balancing and stress-relieving, the teeth were cut and the gear installed.

Smaller gear blanks can be gas-cut in one piece from steel plate of the proper thickness, with a hub piece welded on. Machining of teeth, bore and hub faces completes the gear. Another simple shape-cutting operation for a cutting machine is the profiling of wrenches. In addition to the many standard sizes of wrenches needed, steel mills require numerous odd-shaped wrenches for such purposes as billet turnover, mill base wrenches, etc. These are often flame-cut in multiple, generally from SAE 1045 steel suitable for furnace hardening after cutting.

DIES AND DIE HOLDERS

An operation of unusual interest performed in one mill recently involved the shaping of a forging die by the use of an oxyacetylene scarfing torch. This was done to expedite deliveries of forged rudder stocks after difficulties in forging the first few without a die indicated that a die was necessary. An old flat top die was first roughed to shape with a cutting machine, but because of irregularities in contour and the close tolerances required, considerable stock was left. The die was preheated and a large size scarfing torch with No. 17 tip was then used to remove this excess surface stock. From time to time a set of templates was fitted into the die as a guide in shaping and in keeping the surface smooth. This die is sketched in Figure 11. After scarfing, rough spots were smoothed with a hand grinder and the die was stress-relieved. In service it has proved very satisfactory.

Die holders or platens for forging presses can also be made by flame cutting and arc welding with a minimum of preparation. An interesting illustration of this oc-

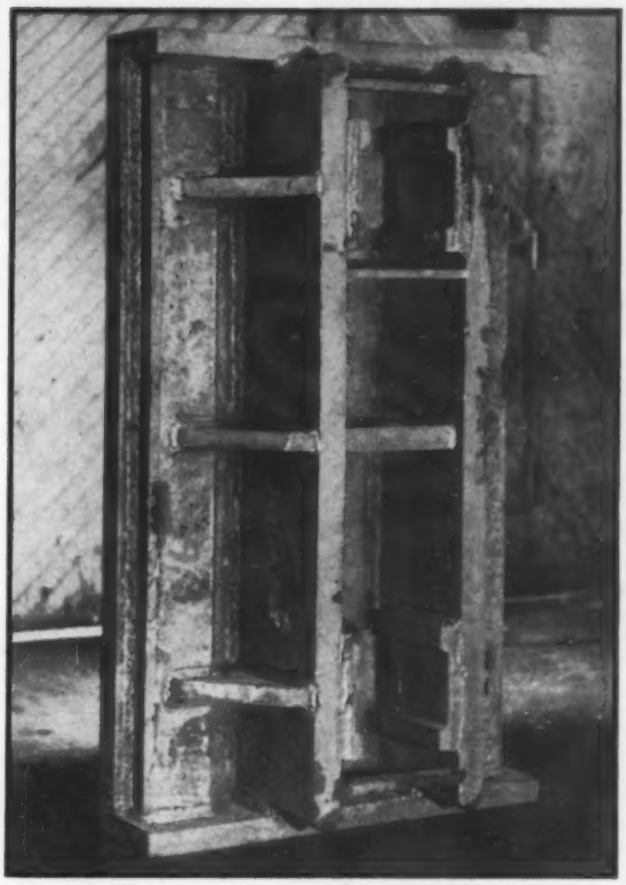


Figure 12 — This welded die holder, weighing 3200 lb, was assembled on rush order to replace a broken cast platen. Staggered welding kept distortion down to a minimum.

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Figure 13 — The valve body at right was made by welded fabrication to replace the old cast valve shown at left. This is a good example of adaptation of design for welding

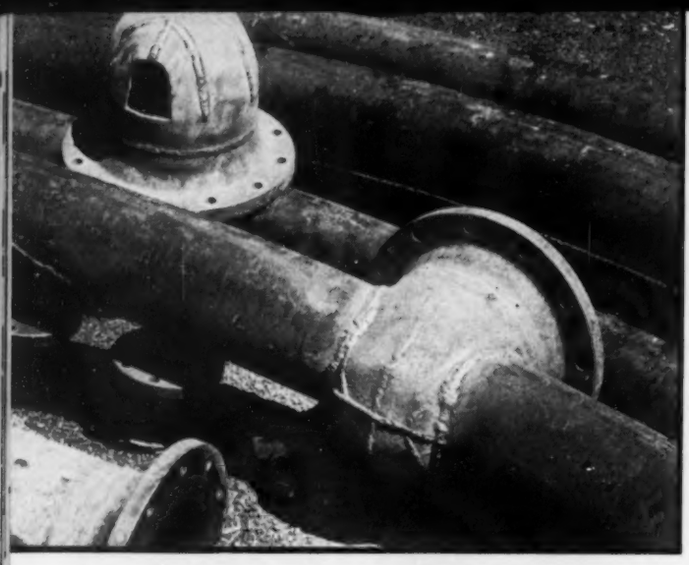

Figure 14 — Details of welded 12-inch bull heads are clearly shown, before and after cutting of inlets for 8-inch pipe.

curred in one plant where three cast iron platens, too lightly designed, failed after a few days service, and replacements could not be obtained for six weeks. A new die holder was fabricated to the dimensions of the casting without bothering to make a drawing. Shown in Figure 12, the platen is 74 inches long, 42 inches wide and 15 inches deep, composed of plate sections ranging from 1¾ to 3 inches thick, and weighing 3200 pounds. Assembly layout work was done directly on the base plate after all segments had been torch beveled for welding. A staggered sequence of welding was carefully followed on the first three passes to keep warpage to a minimum. The total welding time was 78 man hours to complete 111 linear feet of welds. After normalizing, the die holder was within 3/16 inch of finish tolerances.

PIPE FITTINGS

One of the most active divisions of the maintenance organization is the pipe fitting department, which is responsible for the construction of all pipe lines for steam, air, oxygen, oil and gases. It has become standard practice to fabricate almost every type of fitting on all pipe of 2 inches or over in diameter. The advantages of making welded fittings include economy, reduced inventory (since they can be made on short notice) and the total elimination of pipeline leakage through the use of welding fittings in place of screwed fittings.

Among the more unusual and elaborate jobs of fabrication in pipeline work is the valve body shown in Figure 13. Made of rolled plate, flame-cut and in some cases formed to the size and shape needed for each part, this welded valve replaces a cast valve which was no longer serviceable and which could not otherwise have been replaced in so short a time.

Figure 14 shows several fabricated 12-inch bull heads, made as orange-peel closures by oxyacetylene cutting and arc welding. Inlets for 8-inch pipes were cut into the bull head after welding. These fittings served to connect a ring header to a supply line. The flanges for such fittings are commonly cut with a multiple torch machine from scrap pieces of plate. The cutting of pipe

Figure 15 — Part of broken base from an old Corliss engine, prepared for welding. This irreplaceable engine was cracked and broken in many places, but was put back in service in ten days.

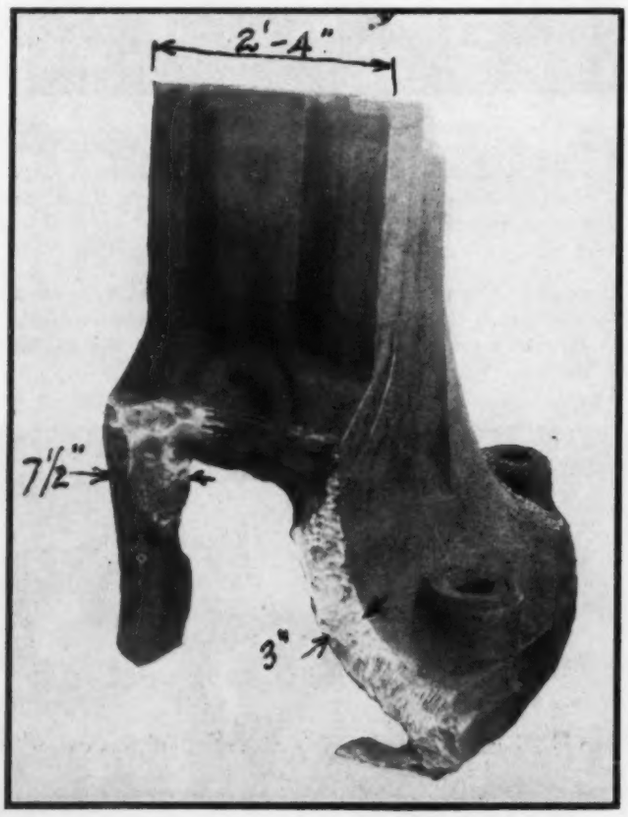

Figure 16 — Gouged-out breaks like these, with gaps up to two inches wide, required over half a ton of bronze weld metal to repair the 60-year-old vertical engine.

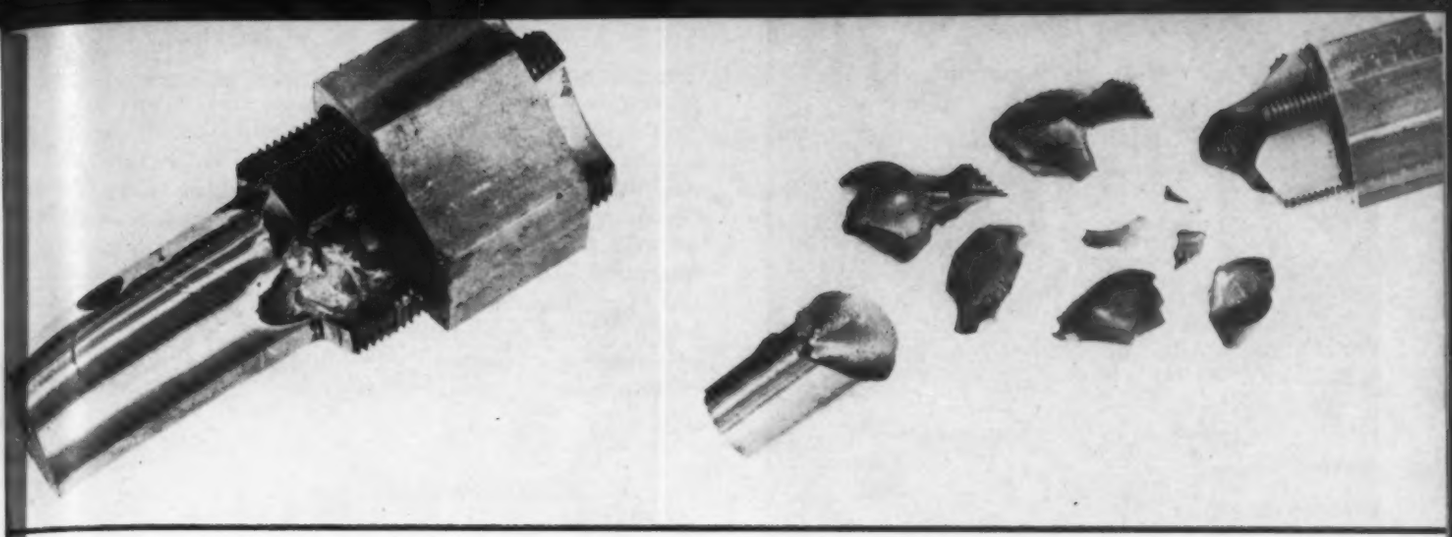

Figure 17 — This completely shattered tap was restored by low-temperature brazing with a silver alloy without significant loss of hardness in cutting edges. Tap after brazing is also shown.

flanges is in fact a good outlet for scrap pieces which are too small to be usable for other purposes.

REPAIRING BROKEN PARTS

Welding departments in every steel mill are experienced in making repairs to broken pieces of equipment such as gears, mill housings, machine bases, and similar iron or steel castings. In many instances, rather than make repairs to an old casting, a replacement part is fabricated by welding, but this is sometimes neither feasible nor economical. One mill, for example, suffered the complete breakdown of a 60-year-old vertical type Corliss engine when, due to speedup of production, the ancient engine was overloaded and cracked badly in the base, uprights and base plate. These cracks caused the 42-inch cylinder to shift, and it became seriously scored. The repair job involved here was unusually extensive, but as no new engine or base of this type could be located, welding was resorted to.

The cylinder was first rebored, and the well-worn piston was built up with 120 pounds of manganese bronze deposited by the oxyacetylene process. Cracks and old carbon arc welds which had given way were washed out with a gouging torch, an operation which required 60 man hours, indicating the magnitude of the job. Figures 15 and 16, showing sections of the base prepared for welding, also reveal the width of the gaps to be filled with weld metal. Back-up plates were employed where necessary, and the braze welding was done with Number Twelve tips and two-flame tips, with ¼-inch welding rods tacked together in bundles of four or five to speed up the rate of deposit. Over 1000 lb of manganese bronze were deposited in four days of uninterrupted welding, and the engine was put back in service ten days after its breakdown.

The engine has proved to be better after repairs than it was before, providing more power through its enlarged cylinder and rolling billets in nine passes where twelve were necessary before. Further evidence of the strength of the welded engine is found in the fact that several 12-inch roll necks have since been broken in the mill without damage to the engine.

The foregoing job is exceptional but is not beyond the capacity of almost any mill maintenance department to perform. Other typical repair jobs on broken castings, which need not be described in detail here, are the braze welding of broken fly wheels and large gears, press frames and the like. While cost is seldom the primary factor in these days of inability to obtain new castings, the saving in dollars is often considerable in addition to the more important factor of getting the equipment back into service promptly. One flywheel measuring 28 feet in diameter and weighing 28 tons, with two spokes broken at the hub, was welded at a total cost of $225, compared with $12,000 for a new wheel, obtainable only after a twelve month wait.

In another instance, incipient cracks spreading over a fairly large area on the upright of a drop hammer frame and threatening breakdown of the frame were eliminated by simply cutting out that whole area with a torch, and replacing it with a patch of 2-inch rolled plate, welded in with steel weld metal. Such repairs are by no means unusual to maintenance crews.

BRAZING BROKEN CUTTING TOOLS

Until recently, broken cutting tools such as reamers, milling cutters, broaches, etc., were not considered suitable for repair by welding. With the shortage of such tools, however, a few plants have attempted to make such repairs by low temperature brazing with silver alloys. These efforts have been entirely successful. It has been proved that if heat input is carefully controlled and kept at a minimum, the loss of hardness on cutting edges is inappreciable and the tool is good for additional service indefinitely.

A tap which was broken into ten pieces is shown in Figure 17 before and after brazing with a silver alloy which is free-flowing at 1175 F. To make such repairs the abutting surfaces are first cleaned, coated with flux and then tinned with the alloy. The pieces are then aligned and heated within a narrow area with an oxyacetylene torch until the alloy melts and completes the braze. Tests of butt joints made in this way have shown a strength of 150,000 psi.

Those shops which have made these repairs extensively have been able to save thousands of dollars a month in reclaiming costly cutting tools. The cost of

Figure 18 — Lancing an open hearth spill measuring 10 x 5 x 15 feet to break it up for remelting.

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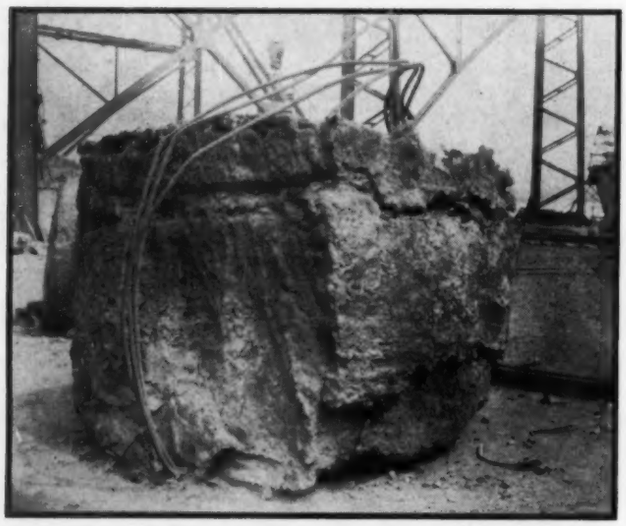
Figure 19 — This large block was cut by the oxygen lance from the spill shown in Figure 18. Dynamite holes were then lanced and the block broken up.



repairing a $400 reamer in one case was only $5. Repairs to broken tools will undoubtedly continue to be a standard practice long after the shortage of new tools is over.

LANCING OPERATIONS

Among the many difficult problems that present themselves to maintenance departments is the removal of open hearth ladle spills and breakouts through the bottom of the furnace proper. Because of limited crane capacity or limitations on crane time which can be allotted to this kind of work, the oxygen lance is now commonly used to break up such spills into smaller pieces which can be more readily handled and removed in a shorter space of time.

Before starting the lancing operation, all loose slag and bricks should be removed to clear the way, both for safety reasons and free handling on and around the spill. In Figure 18 the beginning of the lancing of a spill which occurred in an open hearth pit is shown. This piece measured 10 x 5 x 15 feet and weighed approximately 75 tons. Due to the fact that it was not clear steel but was mixed with slag and burned brick, lancing was speeded by feeding pure steel in the form of old nuts, bolts and other scrap in front of the lance jet to insure continuance of the cut as lancing progressed. Between 20 and 25 thousand cubic feet of oxygen were consumed in 24 hours of continuous lancing to sever this block. Figure 19 shows the surfaces of a piece after lancing. Holes were later lanced into this block, and dynamite was inserted to break it up into pieces of charging size.

CONCLUSION

It has not been my intention in any way to attempt to present a complete picture of all operations of a steel mill maintenance department. The scope of these operations is much too great to be covered in one paper. The foregoing jobs and discussions have been offered either because of their importance in routine maintenance work, or because it was felt that because of some unusual aspect they would be of interest and have some possible application in mills other than those practicing each particular job. Welding departments are called upon increasingly to solve problems or to perform operations in areas of work which previously were regarded as being outside their normal province, and accordingly there is always new information which could be of invaluable importance to the industry as a whole if properly presented and accurately recorded.

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▲ ONE of the major units in the expansion of the steel making capacity of the United States is the plant built for Defense Plant Corporation by the Carnegie-Illinois Steel Corporation at Homestead, Pennsylvania. Consisting principally of an open hearth shop, slabbing mill and plate mill, this new plant was planned and built to work in conjunction with an existing plant to the extent of receiving hot metal for the open hearth charge.

The site selected was an area of 123 acres immediately adjacent to the Homestead Works of Carnegie-Illinois Steel Corporation, requiring the razing of more than 1200 buildings, mostly houses, in one of the oldest sections of Homestead.

In this paper, only the open hearth shop and its auxiliaries will be discussed.

The main building of the open hearth is 162 feet wide and 1404 feet long. The main building columns are spaced 108 feet apart, with an open hearth furnace in each of eleven bays. This leaves a wide charging floor on one side and pouring aisle on the other side of the row of furnaces.

Ingot moulds are returned from the stripper building to the mould conditioning building where there are facilities for cleaning, tarring and hot topping them before they may be run over into the pouring aisle.

Hot metal may be brought in at the lower level and taken up to the mixers by overhead cranes, or in case of emergency it may be taken directly up to the charging floor on a ramp.

There are two levels in the lean-to, the upper level being an extension of the charging floor with tracks for handling charging buggies, the lower for housing boilers, fans, reversing and stack valves. In the stock yard the upper level extends out about half way across its width.

The cinder yard and scrap drop are located at one end of the mould conditioning building. Ore and limestone bins are located under charging floor level at the end of the ramp at the west end.

Figure 1 shows a cross section of the main building, with the smaller buildings on both sides of it. Starting at the left are the tracks for cars bringing scrap into the scrap yard. Storage is on ground level. Charging boxes are loaded on the charging floor level.

In the lean-to are shown the stacks, boilers, induced draft fans, refuse track and cold air fans on the lower level, with the three tracks on the upper level for handling charging buggies.

Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

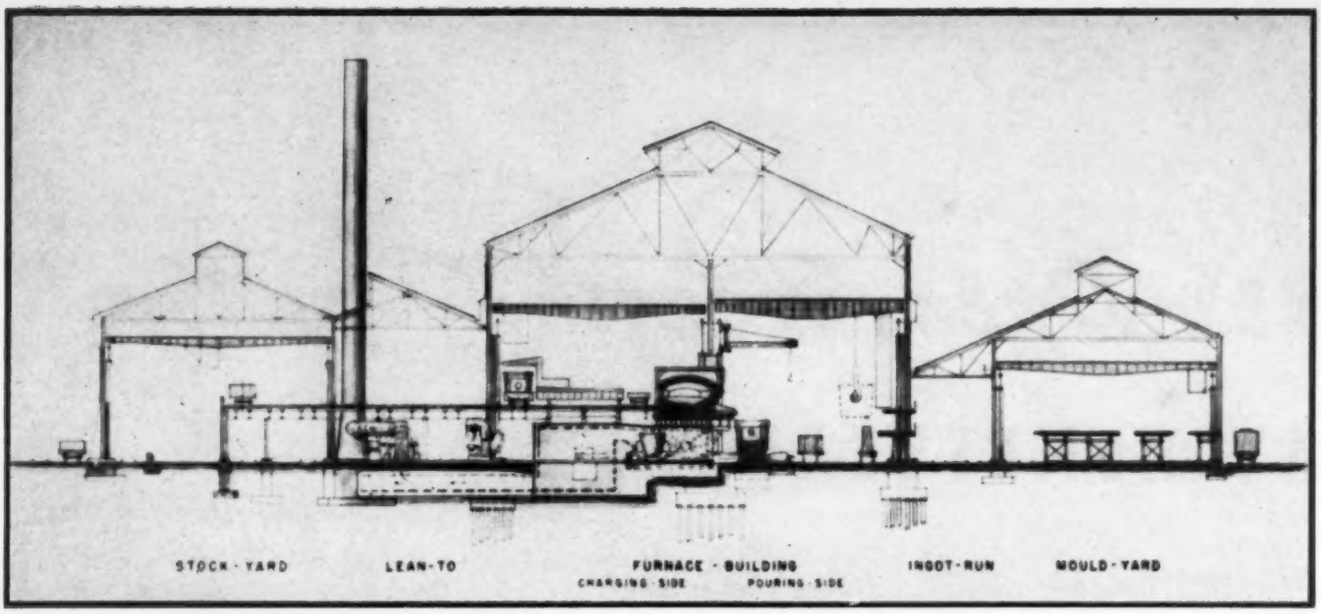

Figure 1 — Section through open hearth buildings showing arrangement of equipment.

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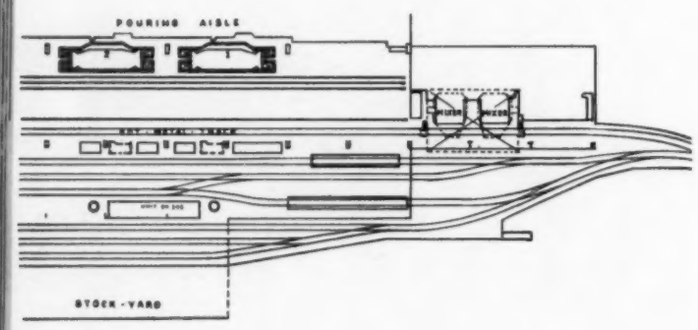
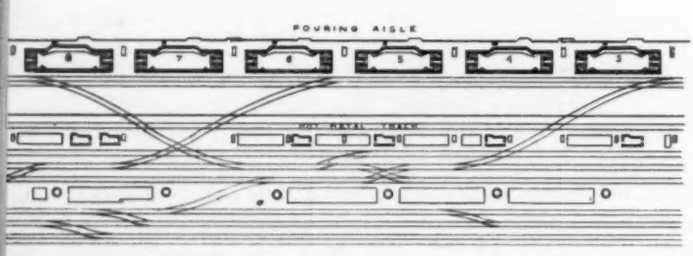
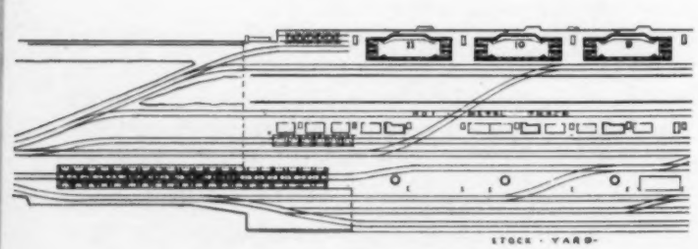
Figures 2, 3 and 4 — Plan of furnace building showing arrangement of tracks and locations of furnaces, mixers, storage bins, etc.







On the charging side of the furnace building the lower level is taken up to a large extent by the furnace checkers. On the upper level are the tracks for hot metal, the charging machines and the run along the furnaces for the charging buggies.

This section shows quite well how the furnaces are set in the building. Under the furnaces, running between the checkers, is the cinder pot car carrying the cinder pot from the front of the furnace, where it receives the front flush through the charging floor, out toward the pouring aisle to receive the final run-off from the furnace.

On the pouring side of the building are shown the relative locations of the steel ladle when the furnace is being tapped and the ladle suspended from the crane when ingots are being poured, over near the pouring platform.

The ingot run is not served by an overhead crane, but has the two tracks for handling strings of ingot buggies. The section of the mould yard is taken to show the arrangement of the hot-topping platforms and tracks.

Most of the building columns are carried on concrete footers. The main building columns are supported on piling, steel bearing piling being used for columns adjacent to the furnaces with concrete piling used for the balance.

The layout of the charging floor is of considerable interest. Figure 2 shows the east end of the charging floor, including the first two furnaces. Here is shown the passageway between the ends of the furnaces, about 18 feet wide, and the platform running along the tapping side of the furnace. The main columns in the center of the open hearth building are shown between the furnaces. Lined up with the next row of columns are the control rooms, bins for alloys, tool cooling troughs and so on.

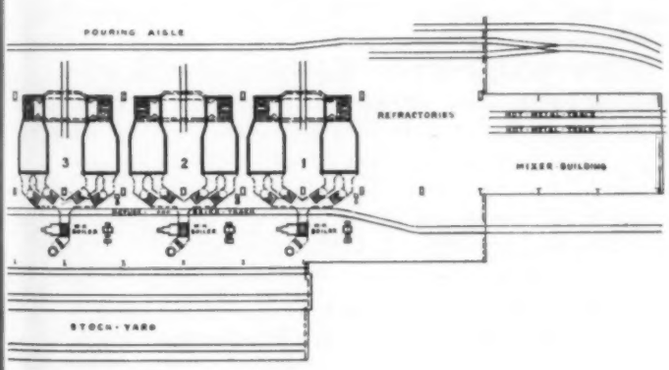
The stacks are shown in the lean-to, out near the stock yard tracks. In line with the stacks and building columns are various buildings such as a two story sanitary convenience station shown here. This layout shows the end bay which is used for storage and main-

tenance work. The mixers are also shown, with the tracks used to take the hot metal to the furnaces.

Figure 3 shows another section of the charging floor including the next six furnaces in the line. Here can be seen the layout of tracks arranged so that charging boxes can be shifted across the scrap yard tracks to the furnaces at different places. The stock yard scales are in a section of track over near the stock yard, with the scale house in line with the stacks, sanitary and convenience station, rectifier station and maintenance shops.

The line of buildings closer to the furnace includes the control houses, various bins for alloys and additions, as well as the chemical laboratory, where some preliminary tests are made. At the east end of this row of buildings is one of the two carbo-analyzer buildings where preliminary carbon determinations are made. These buildings are connected to the chemical laboratory by means of a pneumatic tube system used to transport samples.

The west end of the charging floor shown in Figure 4 includes the last three furnaces with their accompanying control houses, bins and stacks. In this end of the building are the ore and limestone bins, where the material is dumped from cars through grating in the floor into the bins below. The dolomite bins are under another track, with the ferro-manganese and ferro-silicon bins under a short section of track out near the pouring aisle, on which track is mounted the crusher car. The upper end of the ramp from yard level fans out to connect with the various tracks on the charging floor.



Figures 5 and 6 — Plan of lower level of the open hearth at each end of the building.

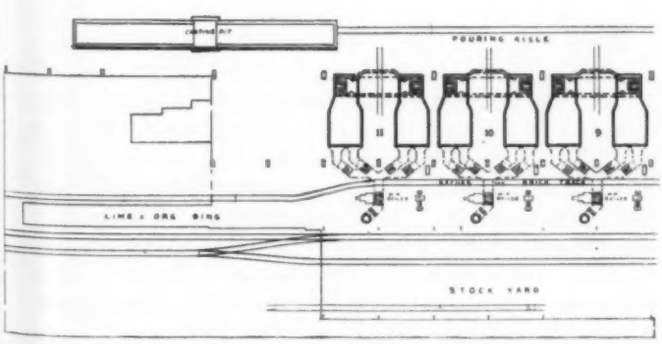


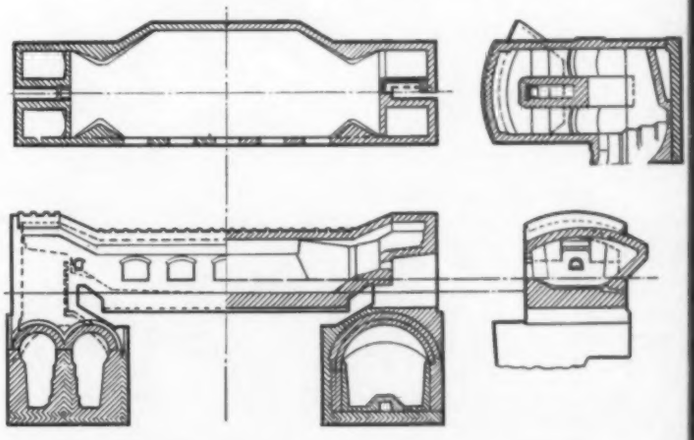
Figure 7 — Front view of furnace showing buckstay and door arrangement.

Figure 5 shows the relative location of the furnaces, checker chambers, flues and stack as seen on the main floor level. In the last bay of the main building are the refractory handling facilities, anthracite drier, stopper rod making bench and dryer, blacksmith forge, etc. Bins are also located here for storing such material as clay and brick-bat. Out in the pouring aisle are the ladle repair pits. In the mixer building are the tracks for incoming hot metal and a pit for hot metal ladle repairs.

The refuse and brick track is shown near the reversing valves, and the track for the cinder car is indicated between the checkers. This lower level is paved throughout so that lift trucks may be operated in the area between the checkers and stacks.

Figure 6 is a plan of the yard level showing the west end of the open hearth building. Here can be seen the location of the track under the ore and limestone bins in relation to the furnaces, and also the last bay in the

Figure 8 — Sections showing furnace brickwork.



building containing the dolomite conveyor and elevator and a storage area for brick.

The lines of the furnaces conform generally to standard open hearth practice, and are the results of considerable study by the Open Hearth Committee of the United States Steel Corporation. Overall length of brickwork as shown in Figure 8 is 87 feet giving an effective bath area at fore-plate level of about 52 feet long and 21 feet 9 inches wide. The burners are set in a "dog house" extending in the end of the furnace for a distance of about 11 feet, set between the two up-takes. Some of the roofs are 18 inches thick with 22½ inch ribs while some of them have been built with 18 inch brick at the shoulders, the balance of the roof being made of 13½ inch brick with 18 inch ribs.

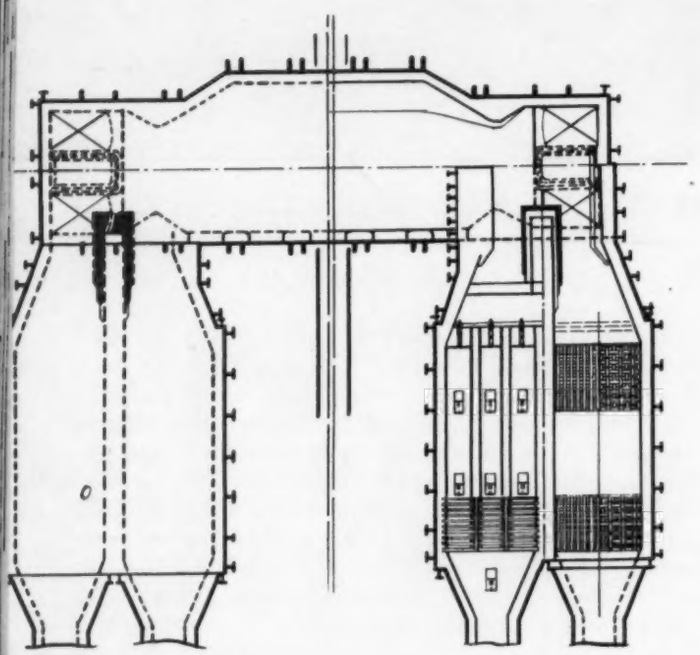
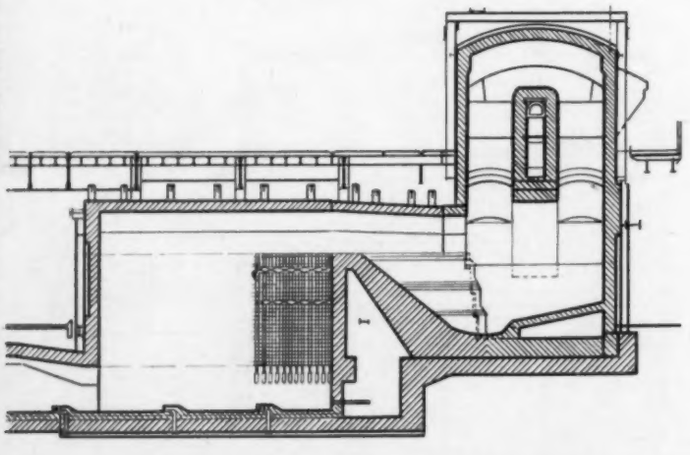


Figure 9 — Plan view showing arrangement of regenerator chambers.

Figure 10 — Sectional elevation through slag pocket and regenerators.



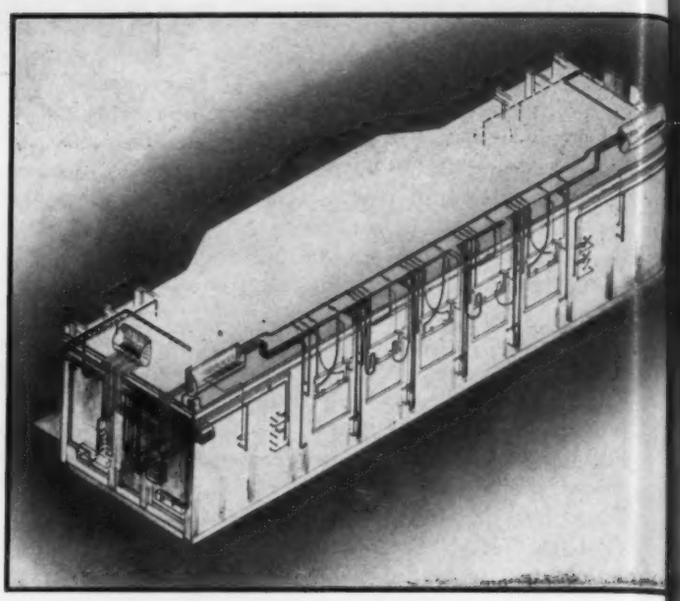


Figure 11 — Perspective drawing showing arrangement of water piping for cooling.

The slag pockets are large, 18 feet by 18 feet by 16 feet deep. The two side walls are protected by false walls with sand behind them, so that a minimum of damage is done to the main walls when slag is removed. To assist in breaking the slag in the pocket, there is a narrow tunnel built on the floor and running 11 feet back from the bulkhead, so that a heavy beam may be inserted under the slag and used as a pry to loosen it up.

Figure 9 shows, in plan, the arrangement of furnace and checkers. The checker chambers are large, two chambers for each end of a furnace. The actual checkerwork in each of the four chambers is about 13 feet wide, 30 feet long and 14 feet high, giving a volume per chamber of about 5500 cubic feet or 11,000 cubic feet of checkers for each end of the furnace. The checkers are set up with 7½ inch vertical flues.

Figure 10 is a section through the slag pocket and checkers showing how they are located in relation to the charging floor. Built into the floor of the checker chamber are shown the soot blowers which are connected to the 300 pound steam supply. These nozzles are built in the floor of the flues at intervals, and may be operated so that soot is blown progressively toward the stack.

Many places on the furnace are water-cooled, including the doors and frames, the main buckstays on both sides of the doors, and the front skewback where archless door frames are used, with a separate cooler over each door. Pipe coolers are built in the monkey walls, and one is placed in the upper portion of each bridge wall. A cooler is built in the end wall at each up-take. On the burner dog-house there is a water-cooled roof, and hair pin coolers are built in the side walls. The dog-house has a water-cooled nose and there is also a water-cooled nose on the burner proper.

Water from the above points flows into four boshes on each furnace. The water required by the reversing

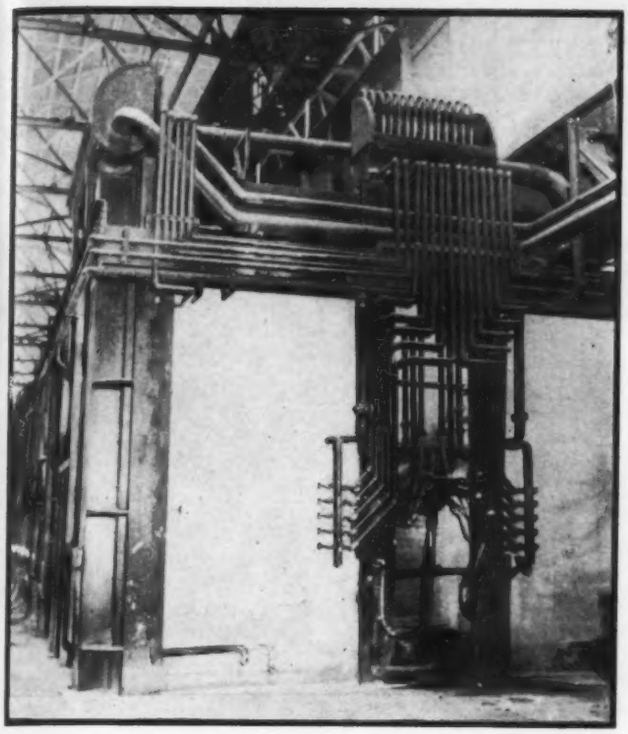


Figure 12 — Four boshes collect water used for furnace cooling. This water is then used for cooling reversing and stack valves (above)

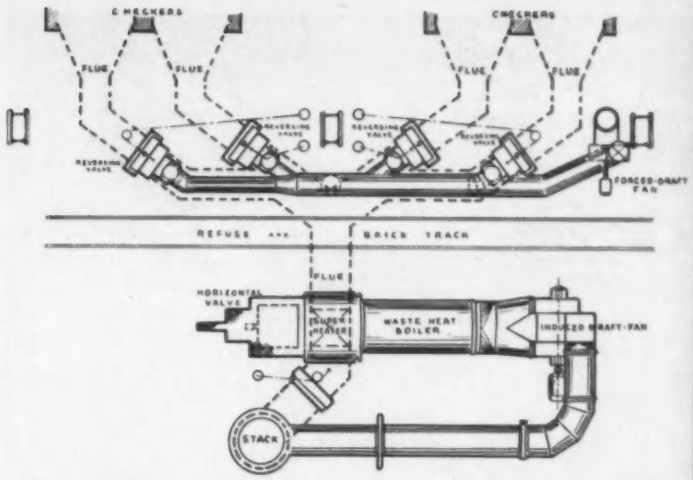


Figure 13 — Drawing showing arrangement of flues, valves and waste heat boiler. (above right)

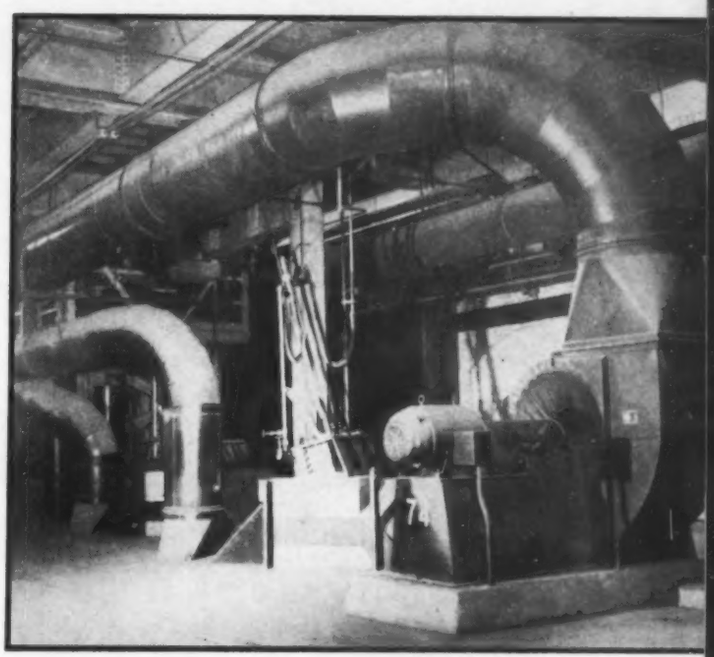


Figure 14 — Forced draft fans supply air to the furnaces, putting it into the flues at the reversing valves. (right)

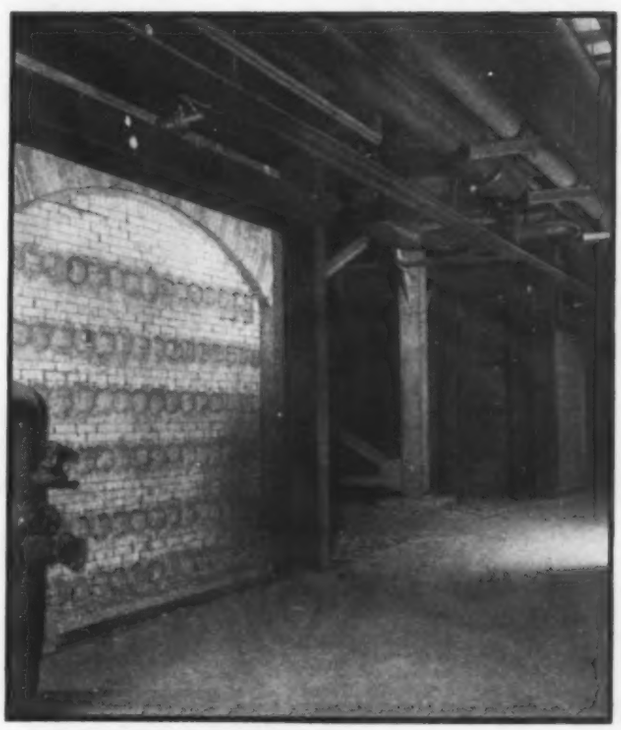


Figure 15 — View of end wall of checker chamber, showing radiation pyrometer at top of wall. (below right)

valves and the stack valve comes from these boshes, the balance going to the sewer. Figure 12, a view of the end of a furnace, shows the arrangement of the cooling water piping on the end wall with the boshes above.

Waste gases are taken from the two checkers at one end of the furnace through two separate flues, through two reversing valves, and finally to a common flue, all under the floor of the lower level. The hot gases normally are drawn up from the flue through superheater and waste-heat boiler, through the induced draft fan, and from there through a steel duct under the charging floor and into the stack. If the boiler or the induced draft fan is out of service, a horizontal valve closes off the opening leading from the flue up to the boiler, and the stack damper is opened. The furnace may then be operated with natural draft. All underground flues have 13½ inch brick walls and arch, with 4½ inches of insulating concrete outside the brick. The stacks are 150 feet high and 7 feet diameter inside the brick lining.

The waste heat boilers are of fire tube design, built to generate steam at 300 psi and 650 F total temperature.

Air for the furnace is put into the flues at the reversing valves.

Figure 14 shows the forced draft fan and the ducts which handle the air.

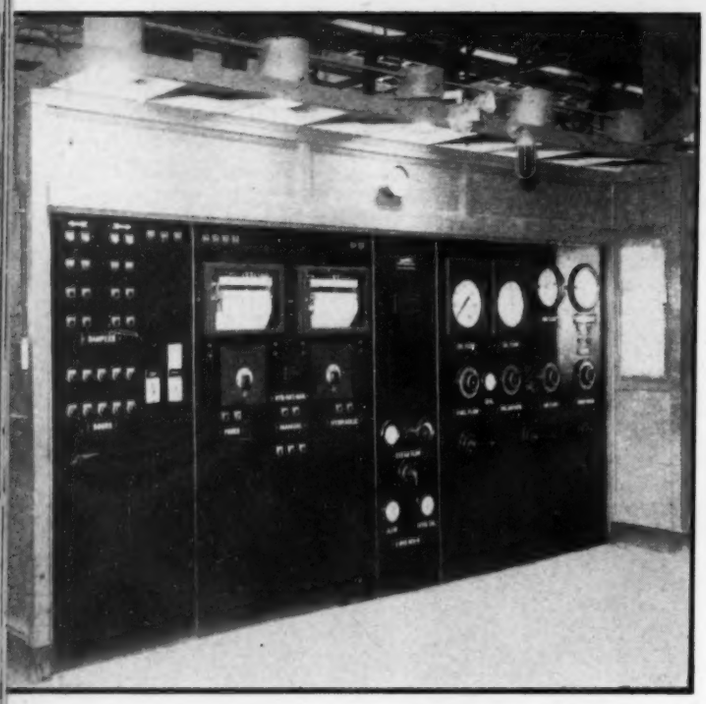
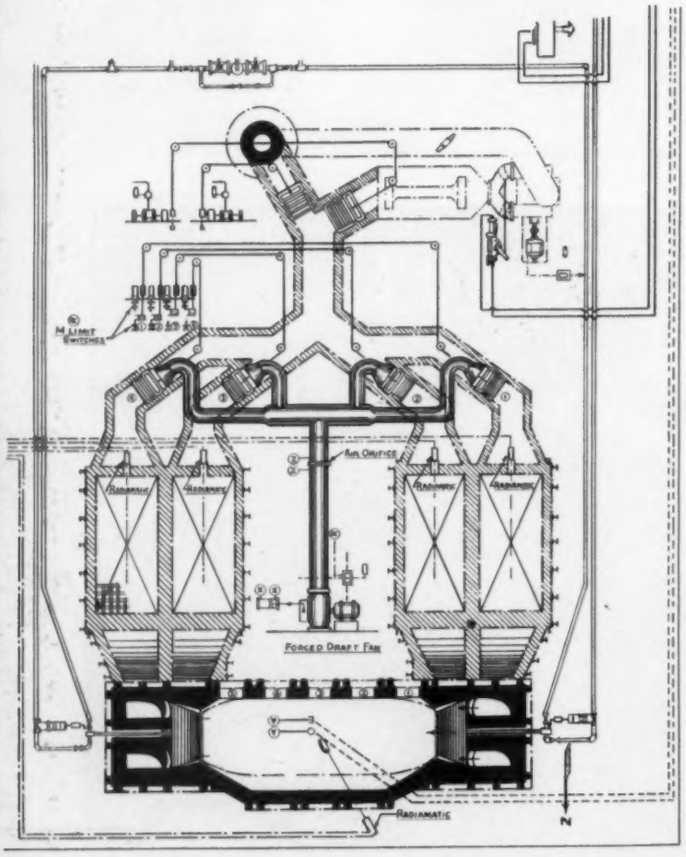


Figure 16 — The furnace control panel forms part of the front wall of a control house. (above)

Figure 17 — Diagram showing arrangement of furnace controls. (below left)

Figure 18 — A casting pit provides facilities for pouring and slow-cooling large ingots. (below right)



In Figure 15 may be seen the location of the radiation type unit installed in the end wall of the checker chamber, near the top, to measure checker temperature. Suspended under the floor is the piping carrying service water, city water, steam, fuel oil, etc.

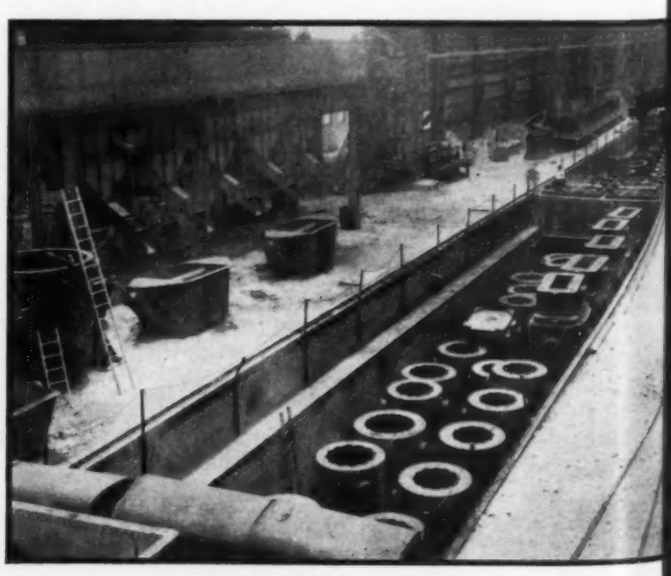
The furnace controls for each furnace are housed in a separate steel house, a portion of the front wall of which is the control panel containing the recorders, indicators, control levers, push buttons, etc. In this way it is not necessary for the operator to enter the instrument house to make any adjustments. He may stand in front of the panel, open and close doors, operate waste gas valves and make adjustments to fuel, air and furnace pressure, observing the action of the furnace at the same time. The electric starters and controllers for door hoist motors, valve operating motors and fans for each furnace are set up in the control house for the individual furnaces.

The furnace controls were laid out with the idea that they should be automatic as far as practical, but so arranged that the operators could at any time easily make required adjustments.

Roof temperature is measured by a radiation type instrument mounted to sight through the back wall of the furnace on a point close to the center of the underside of the roof. This temperature is recorded on an instrument on which the operator may set the maximum roof temperature. The controls will automatically cut back the oil and air flow to the furnace if the roof temperature goes above this point.

Checker temperatures are measured by radiation units mounted in the checker chamber end walls and sighted on the top of the checkers at a point a few feet from the furnace end of the checkers. This means, of course, one unit for each checker chamber, or four per furnace. These temperatures are recorded on a four-record chart.

Normally, the furnace is reversed automatically when either of the two checkers being heated reaches the "floating" control temperature. Minimum and maximum timers are mounted on the panel, both arranged to be easily set by the operator. Reversal cannot take place automatically in less time than that set on the minimum timer, nor can the time between reversals exceed that set on the maximum timer. If either of the



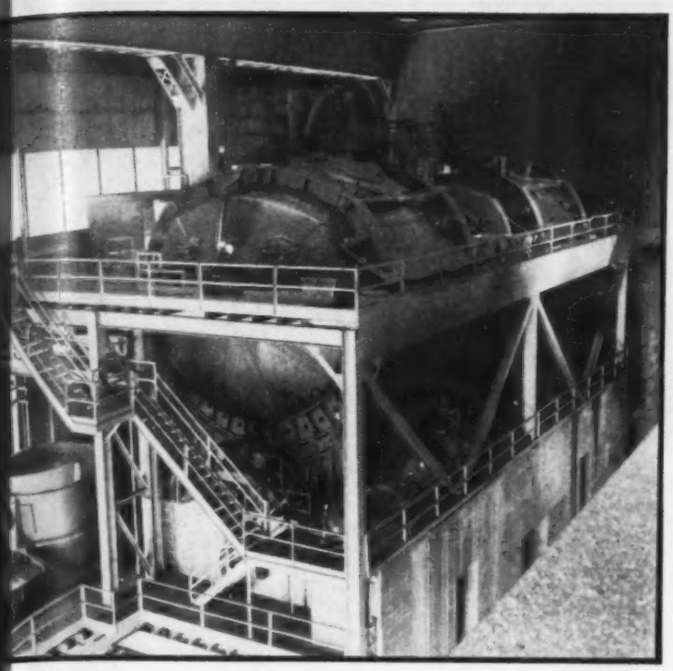


Figure 19 — Two 800 ton hot metal mixers are located side by side at one end of the furnace building.

two checkers reaches the "floating" temperature as then set in less time than the minimum time, reversal does not occur until this minimum time has elapsed, and the "floating" control temperature is automatically raised to the temperature of the checkers at the time of the reversal. If the "floating" temperature control point is not reached by the time set on the maximum timer, this timer reverses the furnace, and the "floating" control temperature is automatically set down to the temperature of the checkers at the time the furnace was reversed. This means that the "floating" control temperature is raised and lowered as required with the progress of the heat. This combination of time and temperature controls is designed to keep in balance the two ends of the furnace.

To protect the brickwork in the checkers, there is superimposed on the above controls a contact which will reverse the furnace if any of the checkers reach a predetermined high temperature, regardless of elapsed time. The furnace may be reversed at any time by simply pushing a button.

Furnace pressure, measured near the center of the roof, may be maintained automatically. This is ac-

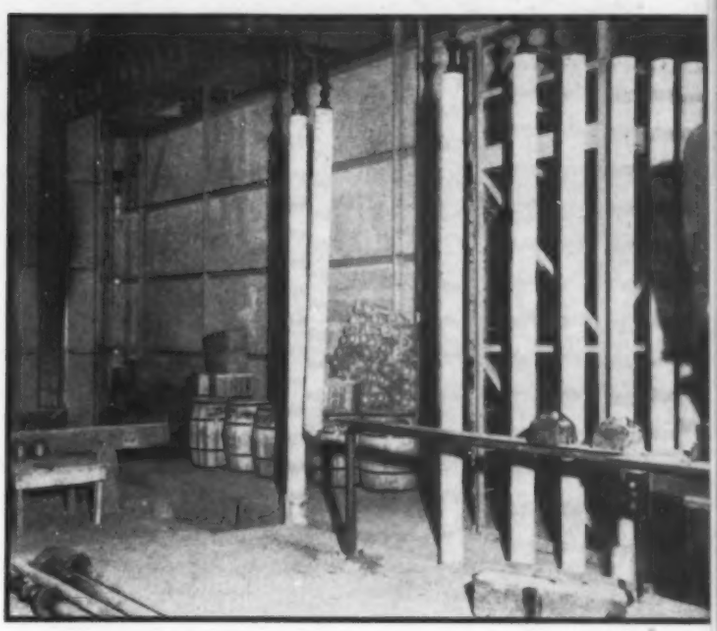


Figure 20 — An overhead conveyor chain carries completed stopper rods through a drying oven.

▲

Figure 21 — View of equipment for drying and bagging anthracite coal used for recarburizing.

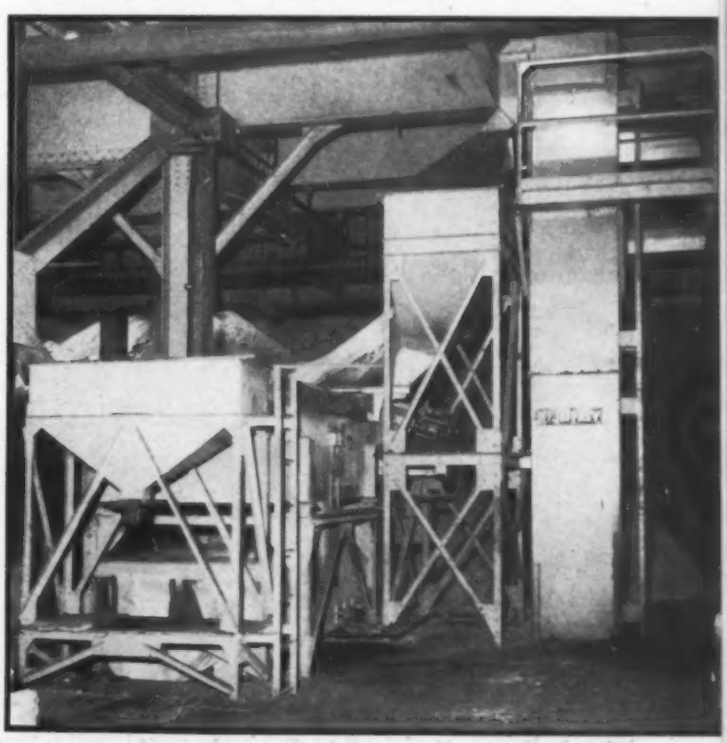
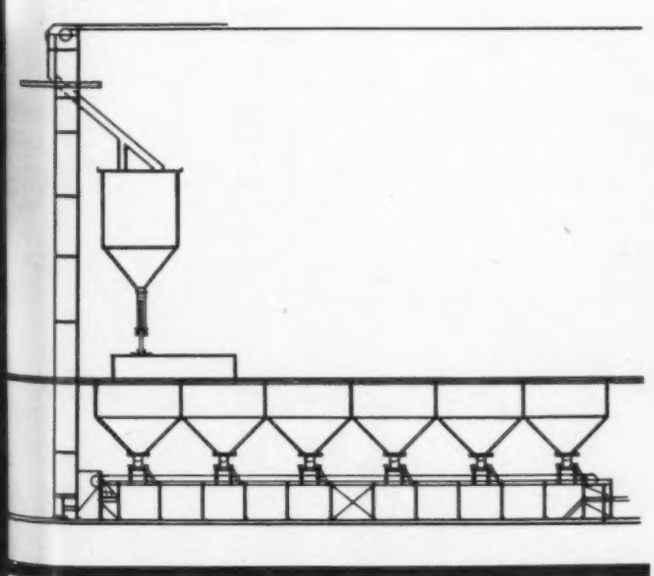


Figure 22 — This sketch shows the handling arrangement for dolomite.



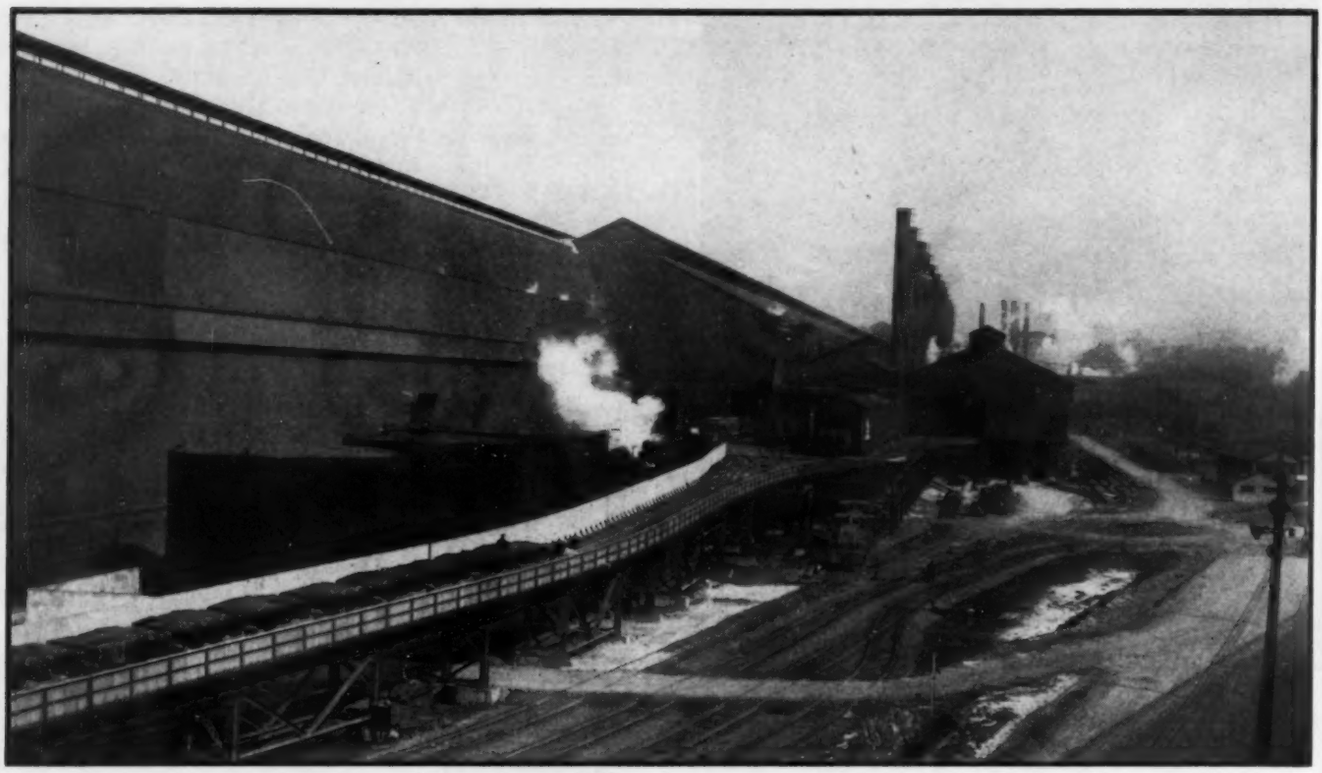


Figure 23 — View of open hearth from the west end, showing ramp leading to charging floor.

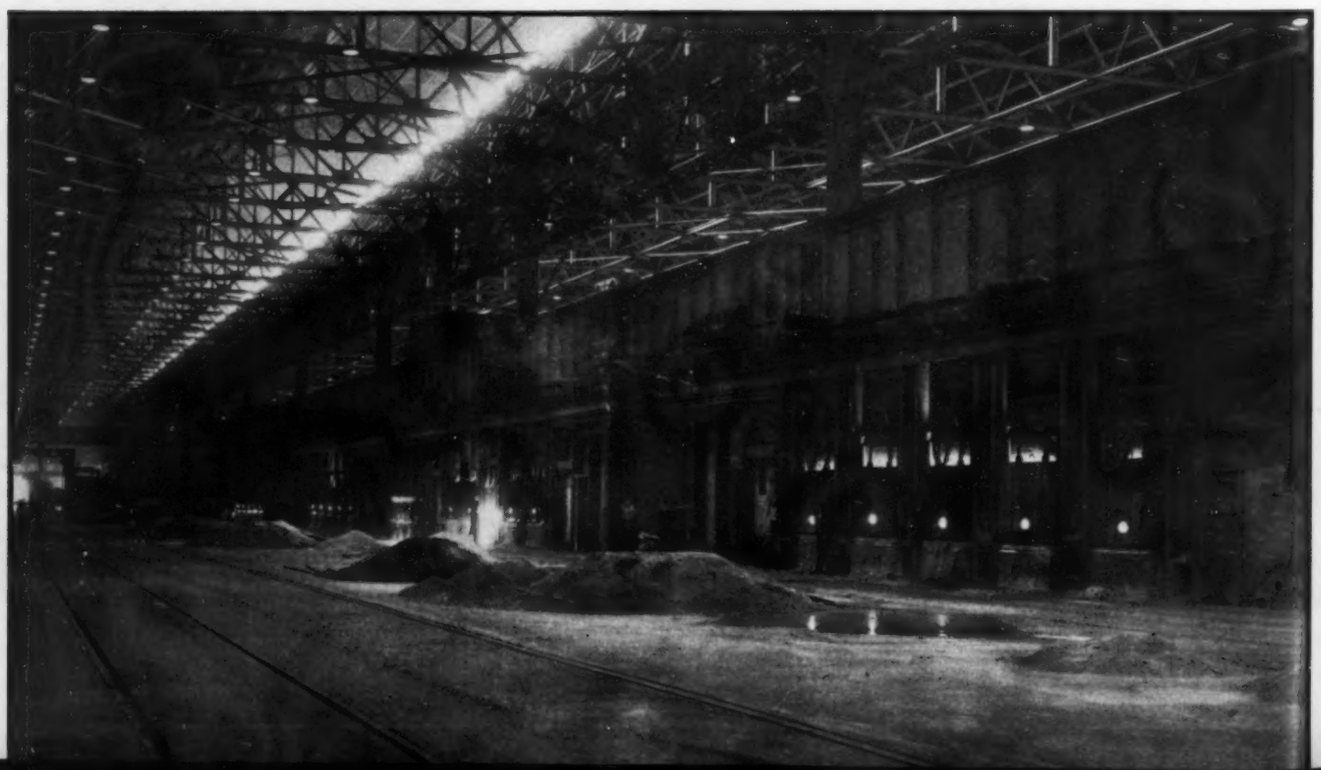
complished by positioning the louvres in the inlet to the induced draft fan. Any adjustment in furnace pressure may be made by changing the setting on the dial on the panel and leaving the control on automatic, or a handle may be thrown to manual position and the louvres in the induced draft fan set as required by means of the furnace pressure gauge.

The controls are designed to maintain a constant flow of fuel to the furnace, this rate of flow being set by the operator on a dial on the panel. The measured oil flow is indicated on an easily read dial, and recorded and integrated by a recording instrument. If required, the oil flow may be manually controlled.

The amount of air going to the furnace is kept constant by the controls which operate vanes in the inlet to the forced draft fan. The quantity of air desired may be easily set on the panel by the operator.

There is also provided a control designed to maintain a constant fuel-air ratio, if the operator wishes to maintain any certain ratio. This fuel-air ratio is adjusted by setting a dial on the panel.

Figure 24 — The entire open hearth plant is laid out for efficient operation, with liberal working areas.



Large ingots, are poured in the casting pits (Figure 18). This pit, about 285 feet long, 21½ feet deep and 20 feet wide is arranged for basket pouring, having the small ladle held in a motor-driven carriage. Four slow cooling pits are built into the large pit, each with a cover so arranged that the amount of air drawn through them by natural convection may be easily regulated to adjust the cooling rate.

On the charging floor is the crusher car carrying the two crushers used for ferro-silicon and ferro-manganese. The ore passes through the crushers into the proper bin under the charging floor. The desired ore is run out of one of five chutes into handling boxes as seen here.

There are six annealing pits which are used to heat or cool large ingots of special analysis following carefully laid out time-temperature curves. Each pit is 14 feet by 15 feet by 18½ feet deep, and is fired on two sides, two burners per side, one above the other. Waste gases are taken out at the four corners. The pressure in the pit is automatically controlled. While heating, the pressure is kept constant. While cooling, the negative pressure in the pit is automatically controlled so that the amount of air to give the desired amount of cooling is drawn into the pit through openings in the cover.

Figure 19 shows the two 800 ton hot metal mixers. Here is shown the tilting gear, a portion of the operator's control house, and in the lower left hand corner, the hot metal transfer car with a ladle ready to receive hot metal from the mixer.

Under the west end of the charging floor are grouped together a press for straightening stopper rods, special benches for working on them, and a drying oven (Figure 20). The conveyor built into the oven has a large number of hooks suspended from a conveyor chain, so the stoppers are moved along one at a time and held in the oven until they are needed.

The method used for drying anthracite coal used for recarburization is shown in Figure 21. The dryer has a vibrating screen on a slight slope arranged so that a bed of desired thickness moves slowly across it, while hot air is blown up through the coal. Bagging is made easy by delivering the dried coal out of a small spout above floor level, while a small conveyor takes the coal from a hopper below the floor up to the dryer.

Dolomite is taken into the plant on charging floor level and dumped from the cars into bins under the floor. From one or more of the six bins it is fed to a conveyor which in turn feeds a bucket elevator which takes the dolomite to a bin well above the charging floor. From this elevated bin it is fed by gravity through a swinging spout into the dolomite machine or handling boxes.

Figure 23 shows the open hearth as seen from the high level bridge spanning the Monongahela River. This view shows quite clearly the ramp leading up to the charging floor from the west end of the plant.

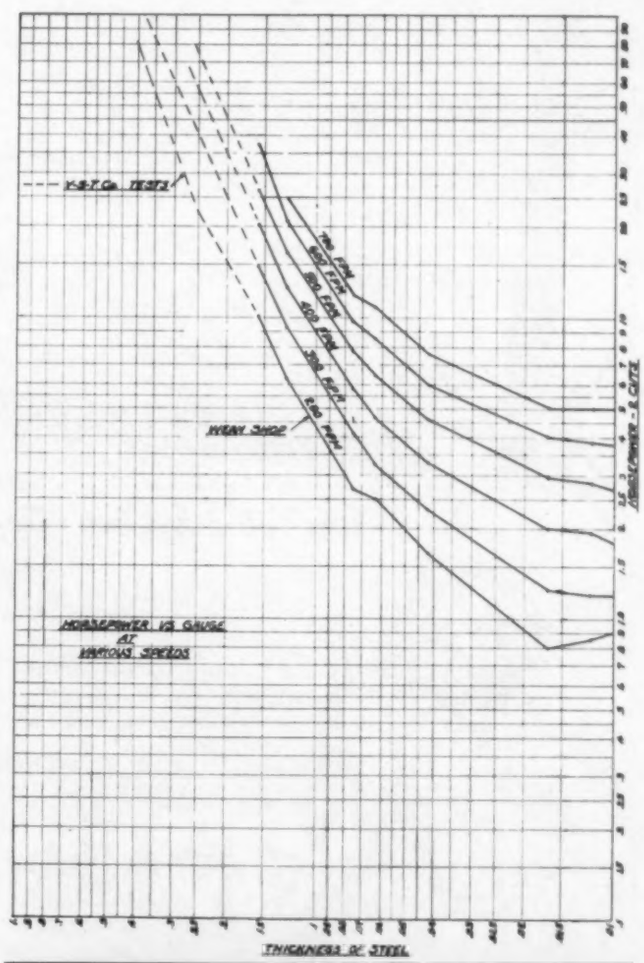
Figure 24, showing the charging floor and furnaces clearly shows the liberal working space provided in this layout, and the plant has now been in operation for over a year — long enough to show that the layout was well thought out. It is interesting to note that a picture almost identical to this could be taken at the D. P. C. plant, Geneva Steel Company, where the furnaces and many auxiliaries were built from drawings made for the Homestead plant.

Revised Curve

FOR SHEARING POWER

The accompanying curve is a revision of Figure 38 from the paper "Shearing Flat Rolled Steel", by F. E. Flynn and D. A. McArthur, published in the December, 1944 issue of IRON AND STEEL ENGINEER. Discrepancies were found in the original curve published with the paper and this revision is given so that the correct information will be available. The revised curve will also be used in the publication of the paper in the 1944 A. I. S. E. Year Book.

Figure 38 — Curves of horsepower for shearing vs gauge at various speeds, drawn entirely from experimental data.



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"Then, three years ago, we switched to Buss Super-Lag fuses—*and we haven't had a single failure since.* What a relief that has been. And today's operating conditions are tougher than they were three years ago, because our production is greater, with less time for maintenance and repairs."

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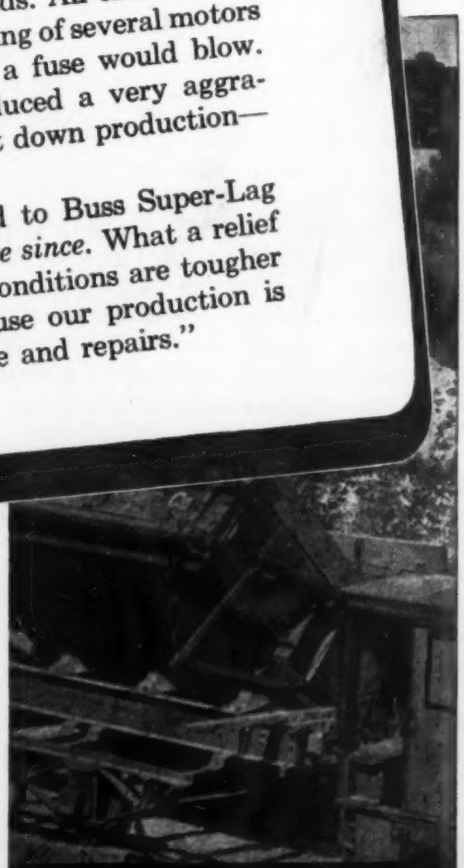

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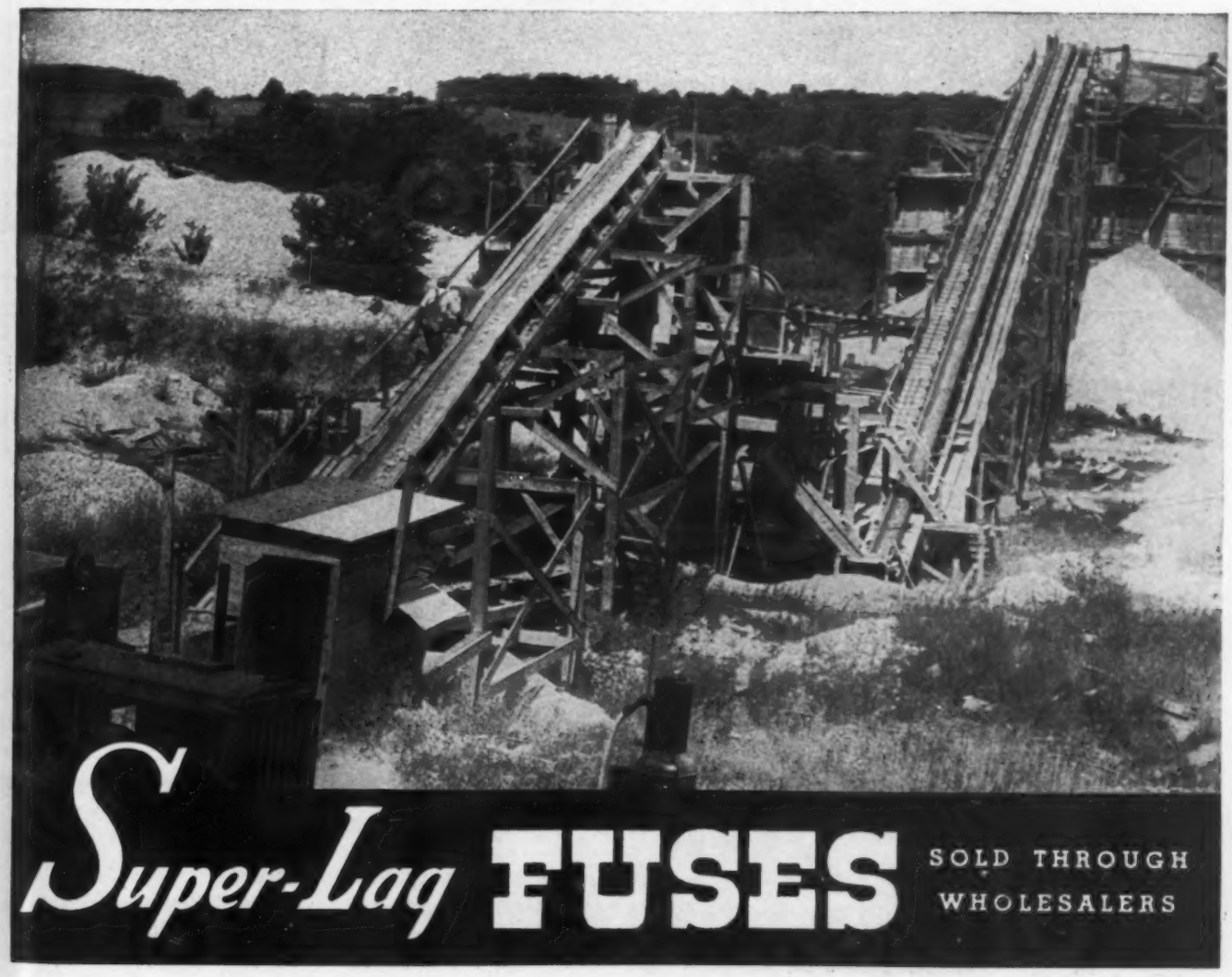

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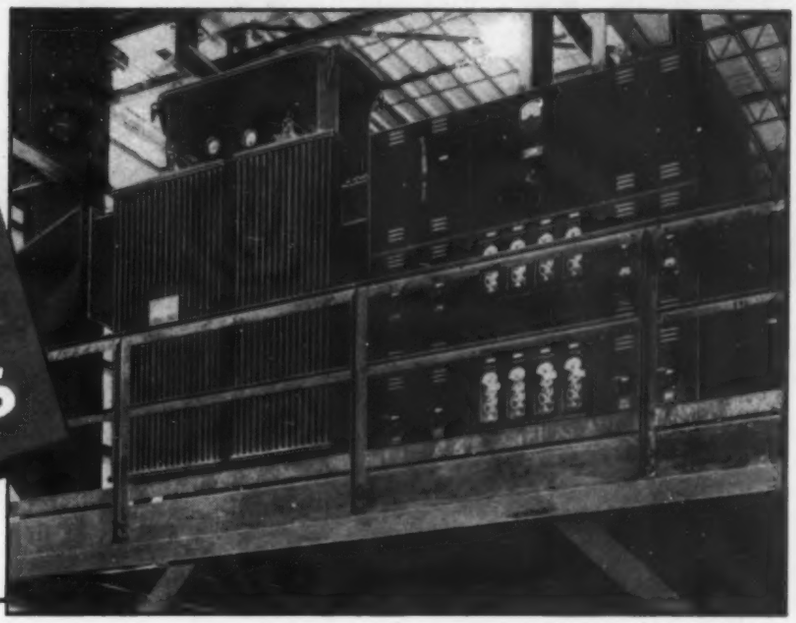


Drawout Circuit-Breakers
—one of the types furnished

Wagner unit substations, consisting of transformers coupled to switch gear having any desired combination of circuit-breakers, meters, etc., can be supplied to meet any industrial load requirement. They can be installed indoors or outdoors, right at the load centers.

CONSIDER THESE ADVANTAGES

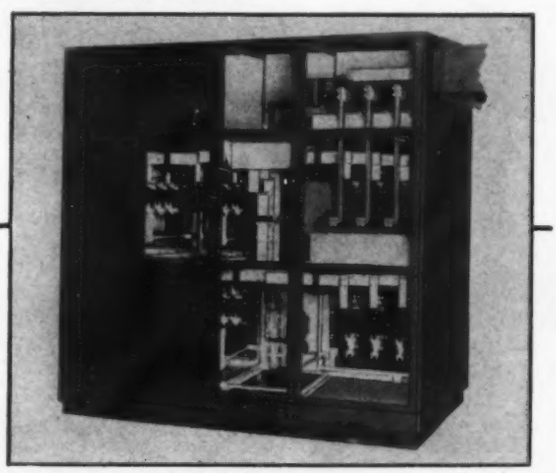
Simplified installation. Complete substation is shipped in one or more factory-assembled units, completely wired, ready for installation and final connection.

Improves performance of motors and lights. Inherent linedrop is avoided by eliminating long low-voltage feeders.

Saving of copper in connecting cables. Locating the transformer near the load allows the use of shorter and smaller cables over a great part of the distance the power must travel.

Low maintenance expense. The complete enclosing of the buses and other equipment practically eliminates cleaning and dust problems and assures safety against contact with live parts.

Provides flexibility to meet future conditions. Can be installed indoors without the use of expensive fireproof vaults.



Switch Gear Equipment . . . Panel Mounted and Enclosed

Drawout circuit-breakers, illustrated top left, are provided with a test position in which the main circuit-breaker terminals are isolated from the bus and feeder circuits. In this position the breaker-control circuits are still connected, permitting test operation of the breaker. Lower left is a rear view of the switch gear equipment; some of the panels on the switchboard have been removed to show bus bars, connections, and equipment. Solid construction is used throughout.

T45-1

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Each of these offices is manned by trained field engineers. They will gladly show you how you can economize on your power requirements with Wagner Unit Substations.

UNIT SUBSTATIONS
are but one of several
WAGNER PRODUCTS
serving industry.

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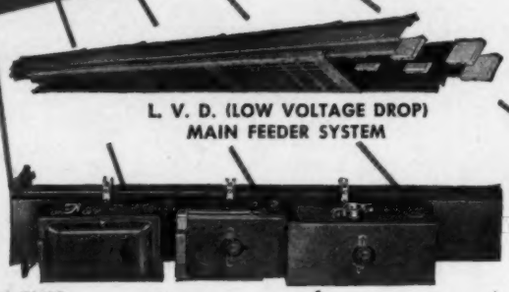
● Trumbullist, a general catalogue of Trumbull products with essential illustrations, is published once or twice a year. We shall be glad to place your name on our list to receive this Trumbull service.



L. V. D. (LOW VOLTAGE DROP) MAIN FEEDER SYSTEM

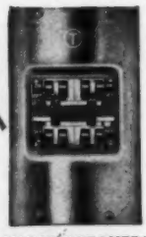
SMALL MOTOR STARTERS

CONTROL CENTERS

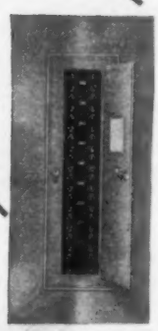
FLEX-A-POWER AND FLEX-A-PLUG PLUG-IN SYSTEM

HEAVY DUTY INDUSTRIAL SWITCHES

MANUAL STARTERS

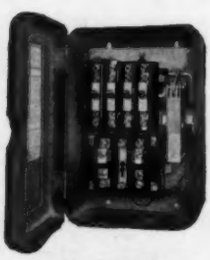


MULTI-BREAKERS

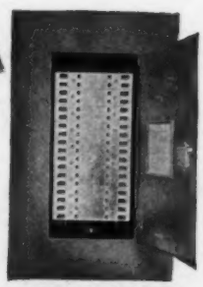


SWITCH AND FUSE LIGHTING PANEL BOARDS

CIRCUIT BREAKERS

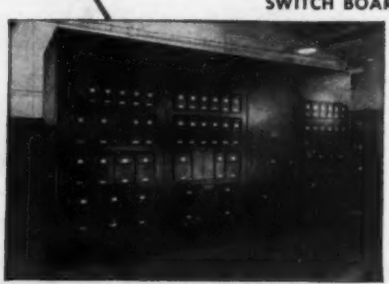


MAGNETIC STARTERS



MULTI-BREAKER PANEL BOARDS

SWITCH BOARDS



THE TRUMBULL NAME PLATE IS KNOWN TO ELECTRICAL MEN IN EVERY BRANCH OF THE FIELD.

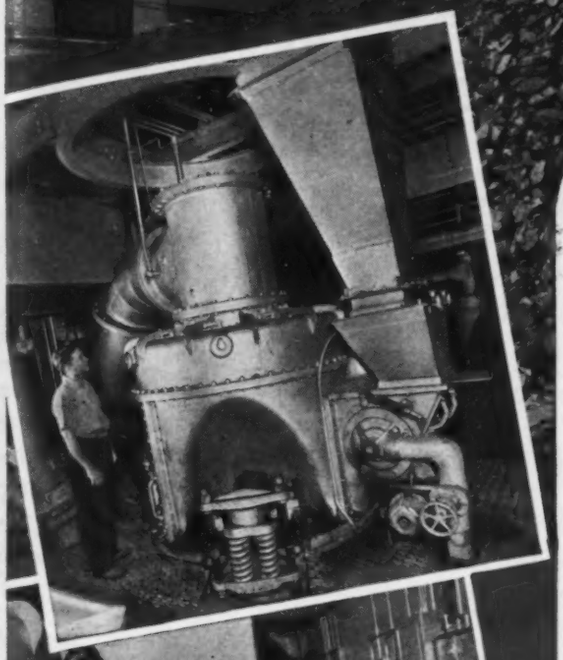
•Trumbull products cover an unusually comprehensive assortment of material for complete systems of interior electrical distribution and control. This advertisement features only the principal broad groupings of these products. Trumbullaid circulars and bulletins available on request.

THE TRUMBULL ELECTRIC MANUFACTURING COMPANY • PLAINVILLE, CONN. • A GENERAL ELECTRIC ORGANIZATION

OTHER FACTORIES AT NORWOOD (CINN.) O. — SEATTLE — SAN FRANCISCO — LOS ANGELES

"MOTOR-DRIVE IS MORE THAN POWER"

RELIANCE V★S DRIVE



INVESTIGATE THE POSSIBILITIES of *All-Electric* V★S DRIVE

OPERATING FROM A-c. CIRCUITS!

CONSTANT MAINTENANCE of a desired steam pressure from boilers is important in power company operation. To you, who may not need to worry about this problem, the fact that it is being handled automatically with the help of Reliance V★S Drive should nevertheless be interesting. It is a good indication of the wide variety of uses to which V★S Drive may be put.

"Reliance V★S" is an all-electric, adjustable-speed drive for A-c. circuits that provides for starting, stopping, speed-changing, smooth acceleration and deceleration, jogging, inching and other operations. All are centrally controlled from a conveniently located panel. Production machinery output is being increased, quality and uniformity of products improved, operator fatigue decreased and operation and maintenance costs lowered by many V★S Drive applications in many industries.

If you haven't investigated Reliance V★S Drive in relation to your own work, we suggest that you call in a Reliance Application Engineer.

RELIANCE ELECTRIC & ENGINEERING CO.

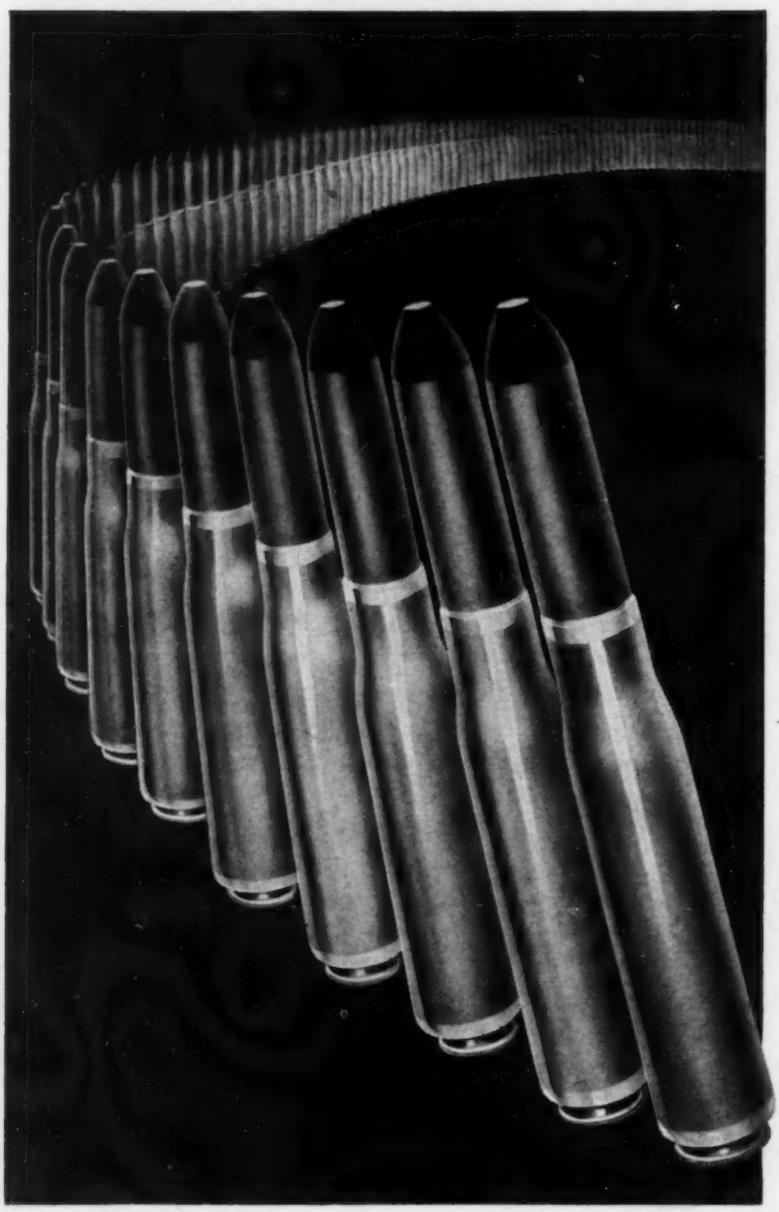
1084 Ivanhoe Road · Cleveland 10, Ohio

Birmingham • Boston • Buffalo • Chicago • Cincinnati • Detroit • Greenville (S. C.) • Houston Kalamazoo • Los Angeles • Minneapolis • New York • Philadelphia • Pittsburgh • Portland (Ore.) St. Louis • San Francisco • Syracuse • Washington, D. C. • and other principal cities

Each of the 14-ton-per-hour mills (upper photo) serves one 500,000 pound-per-hour boiler. Amount of coal fed into each mill, and thence to its boiler, is regulated by a Reliance V★S Drive unit, three of which are shown in above illustrations.

RELIANCE A-C D-C MOTORS

How a Manufacturer Doubled Tap Life and MULTIPLIED PRODUCTION with a Bowser Thread Cutting Oil System



From metal vaults and cemetery equipment to 20 mm shells . . . that's the production switch The Champion Company, Springfield, Ohio, made when Uncle Sam needed help. That's about as broad a jump as you'll come across . . . but Champion made it in stride, with the aid of modern tooling and Bowser Liquid Control.

Tapping is, of course, a major operation in making shells, and high output from the tappers is vital. But steel particles in the cutting oil of Champion's tappers were dulling taps too quickly, causing excessive rejects due to poor threads, and continually causing down time on the machines.

Then a Bowser Pressure Filter was installed and, in the words of a Champion executive, "We cut our tap requirements in half, got a better thread and had practically no down time on our machines."

In the steel industry, Bowser Liquid Control is even more dominant. Bowser Lubrication Systems are standard equipment in over 90 per cent of American steel mills for the lubrication of stands, pinion gear sets, reduction gears, turbines, turbo blowers and pumps. They depend on Bowser, too, for coolant filtration and circulation, the metering of fuel oil, etc.

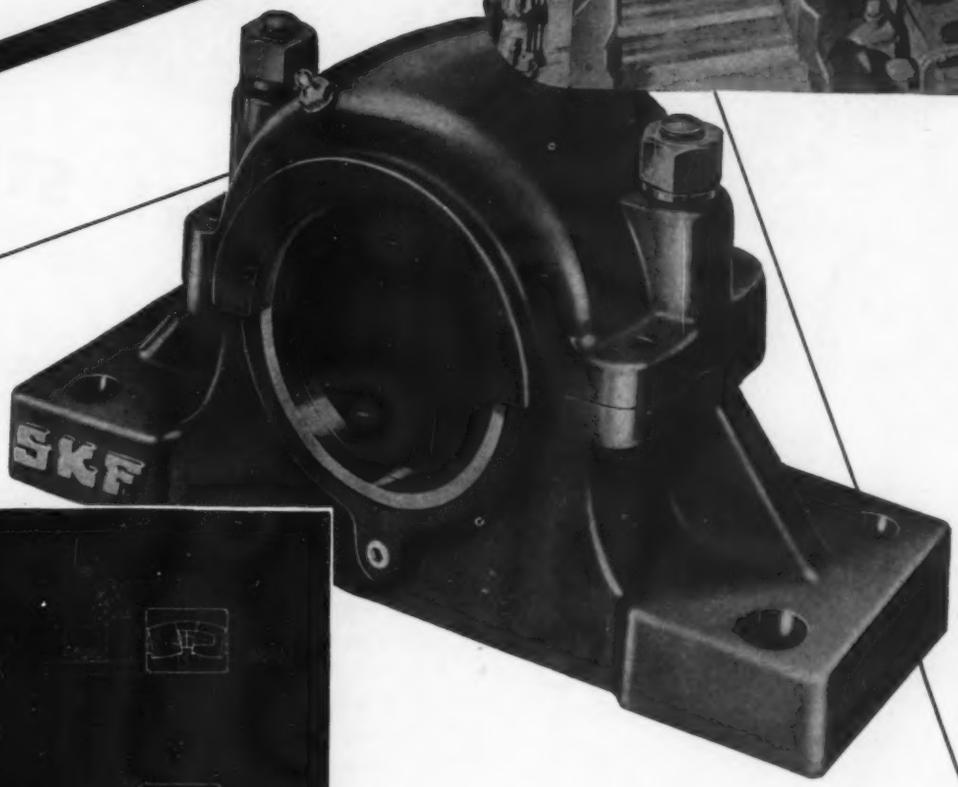
Bowser installations are engineered to be integral parts of the mill. Bearing sizes and pressures, heats, etc., are all factors in the designing. That's why Bowser dominates in this field. Write for full information. BOWSER, INC., Dept. 13-E, Fort Wayne 2, Indiana.

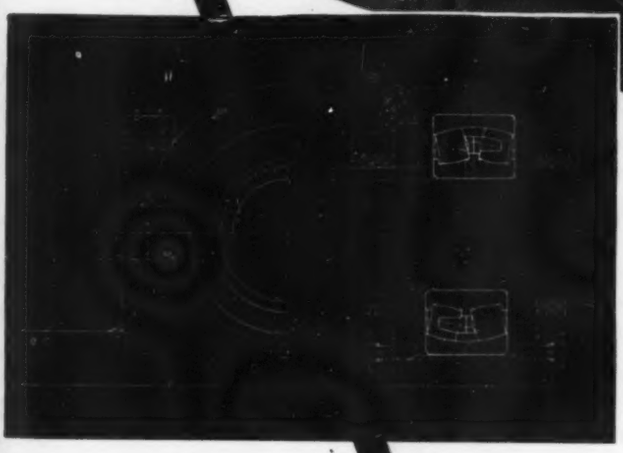
Not only has Bowser's war production earned the Army-Navy E... Bowser equipment has helped earn it for scores of other companies.

BOWSER ESTABLISHED 1885

THE NAME THAT MEANS **EXACT CONTROL** OF LIQUIDS

Exclusively FOR TABLE ROLLERS





Here's a husky, two-piece pillow block that's built to permit maximum load-carrying capacity in minimum space.

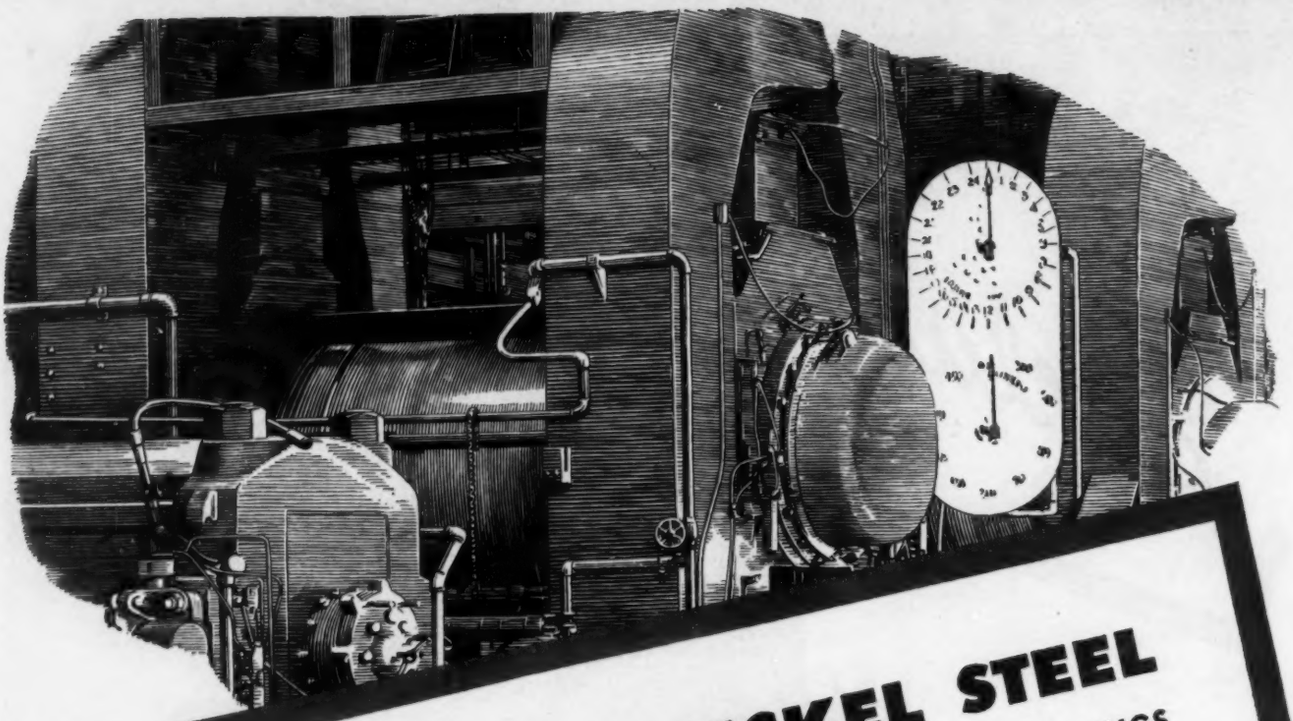
It's triple-sealed to guard SKF Spherical Roller Bearings against entrance of dirt, scale and water. As a result, the bearings run smoothly and continuously throughout a long life.

Our engineers will be glad to supply you with further information.

5700

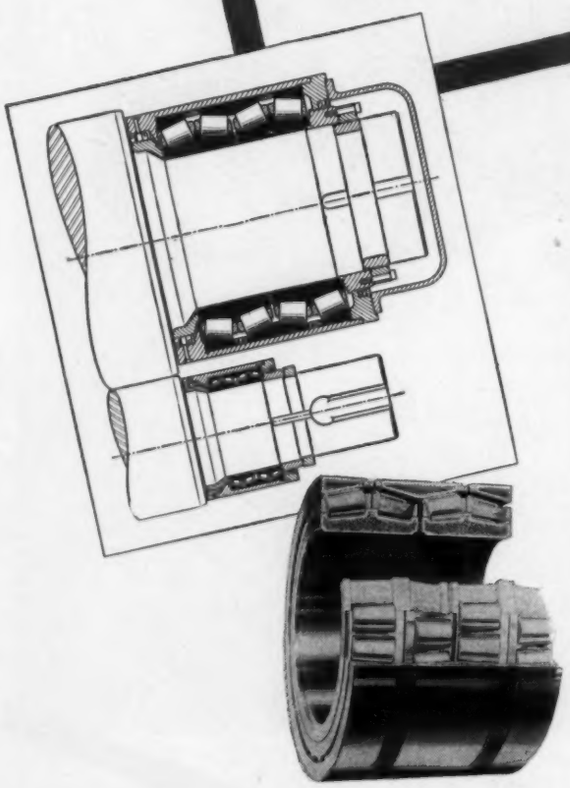
SKF INDUSTRIES, INC., PHILADELPHIA 34, PA.

SKF
PILLOW BLOCKS



CHROME NICKEL STEEL

GIVES LONG SERVICE LIFE TO ROLL NECK BEARINGS



Built to carry the heavy loads encountered in roll neck applications, Torrington four-row tapered roller bearings provide the anti-friction means that help to pile up tonnage records and lower costs. Made of S.A.E.-E3310 steel (with higher nickel content) for maximum service life, these bearings have the additional advantages of simplicity of design and a lubricating system that is controlled within the bearing itself.

Today, Torrington Bearings are also meeting anti-friction requirements in screw downs, edgers, table rolls, shears, drives, pinion stands and many other steel mill applications. Profit by Torrington's specialized knowledge and wide experience by specifying Torrington Bearings when you order equipment.

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA

TORRINGTON BEARINGS

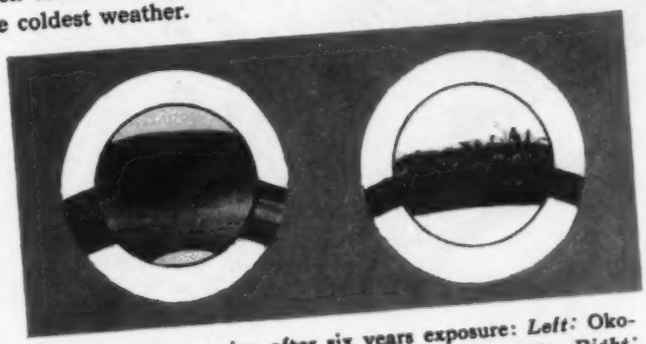
STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

why OKOPRENE protection gives longer life to ELECTRICAL CABLES

Okoprene, compounded with neoprene, is an exceptionally durable covering for cables developed in the Okonite Research Laboratories. It can be bonded to the rubber insulation of individual wires or can be applied as a sheath or jacket over the core of multiple conductor cables. It can be used to protect practically any type or design of cable.

Since 1931, proving ground tests and field experience with millions of feet of wire have been emphasizing the stability and long life of Okoprene coverings under widely varied conditions.

WEATHER RESISTANCE – (Aerial cables, exposed wiring) Okoprene sheaths will not rot or deteriorate when subjected to moisture. The protective covering is flexible at temperatures even lower than minus 18°C. (0°F.) and may be handled in the coldest weather.



Relative deterioration after six years exposure: *Left:* Okoprene sheath smooth and unchanged by elements. *Right:* Saturated braid with compound eroded and braid destroyed.

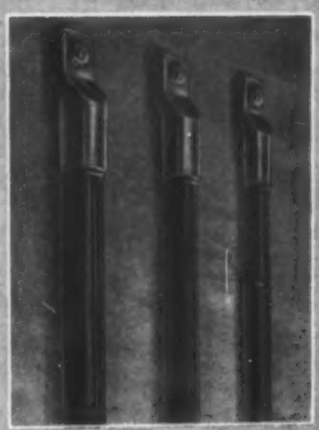
CHEMICAL RESISTANCE – (Cables exposed to fumes or chemicals) The Okoprene jacket has excellent resistance to most acids, alkalies and other corrosive chemicals.

OIL RESISTANCE – (Portable cords, machine tool and shop-wiring, etc.) When exposed to the solvent action of petroleum products, Okoprene sheaths retain their full mechanical strength.

ELECTRICAL STRENGTH – Okoprene itself is an insulating material and thus gives added electrical protection as contrasted with fibrous coverings. When applied over metallic coverings, it protects them from electrolysis. Okoprene will not carry static charges, but does prevent current leakage at terminals and eliminates danger from electric shock.

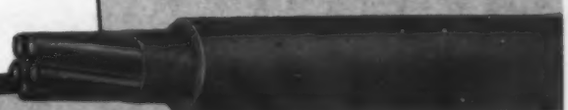
ENGINEERING HELP – Our experience in dealing with electrical problems since 1878 is at your disposal. For further details on Okoprene protection or other data on cables, we suggest you consult your Okonite representative – or write The Okonite Company, Passaic, New Jersey.

NON-FLAMMABILITY – Okoprene coverings do not support combustion.



FREEDOM FROM "SURFACE CHECKING" – Okoprene coverings, which are bonded to the insulation, protect the rubber insulation up to the terminal and prevent "sun checking" or surface cracks.

Single conductor Okolite insulated and Okoprene protected wire.

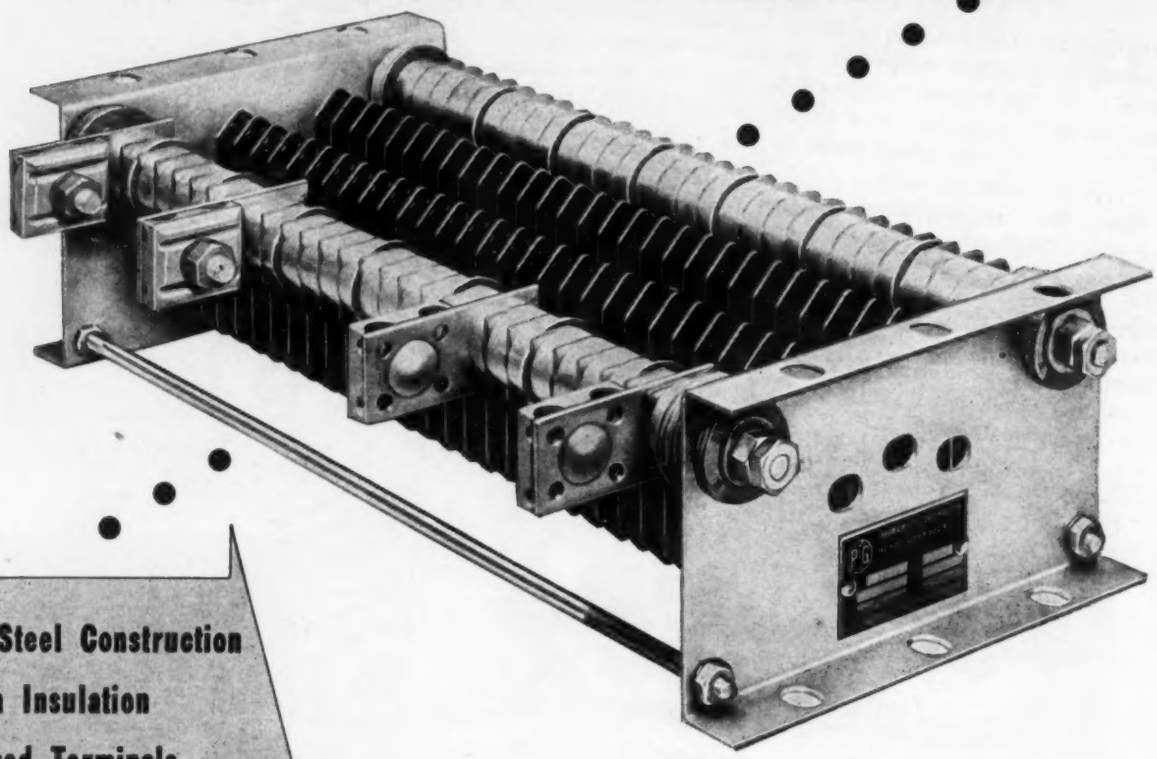


Multi-conductor cable with Okoprene covering over each insulated conductor. Okoprene sheath over all.

OKONITE insulated wires and cables

3942

Built... FOR SEVERE SERVICE



- ☆ All Steel Construction
- ☆ Mica Insulation
- ☆ Rugged Terminals
- ☆ Provision for Expansion
- ☆ Adequate Ventilation
- ☆ Unaffected by Vibration
- ☆ Moisture Resistant
- ☆ Corrosion Protected

P-G *for* Heavy Duty Applications . . .

By use of those durable raw materials... steel and mica, and the P-G exclusive features of design, these Steel Grid Resistors have the extra stamina to overcome factors which often cause resistor failures. Neither vibration, moisture nor corrosive atmospheres have material effect on continuity of service. Try Post-Glover Resistors for heavy duty applications where resistors must give trouble-free service. BULLETIN No. 500 gives detailed information... Copy on request.

P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1890 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

A few of many shapes in which GATKE Bearing Materials have been moulded to machined accuracy. Qualities afforded include great compressive strength combined with shock-absorbing resilience; tremendous wear resistance; light weight (80% less than bronze); dimensional stability; non-scoring and non-abrasive. The large roller in upper left corner is 48 inches long. The largest seal ring is 30 inches in diameter.

try Gatke BEARINGS for your Tough Jobs

...er-lubricated GATKE Bearings on Rolling Mills ...nd wear life up to 2000% and more as com-...d with grease lubricated metal bearings. They ...t tremendous power savings—do not pound ... under great shock loads that cause metal ...rings to flow; eliminate scoring and wear to ...nals.

...TKE Slipper Bearings used in the Universal Couplings ...Rolling Mills give 10 times longer wear life than ...ze—eliminate scoring and excessive vibration thus ...nding life of spindles and avoiding costly recondi-...ing. The two slippers illustrated weigh 204 pounds, ... bronze slippers they replace weigh over 1000 pounds.

These Wonder Bearings have been *smashing performance records* on difficult and unusual applications for more than twelve years.

They are *Custom-Bilt to do the job* where other bearings fail and give results that are *better beyond comparison on all kinds of applications* for which they are recommended.

Getting acquainted with GATKE Bearings *and the wonderful things they do* has opened the way to marvelous performance improvements for designers, engineers and users of all kinds of machinery in most industries.

Try GATKE Bearings on your toughest job. The results will open your eyes to performance improvement opportunities of incalculable benefit.

Complete information on request.

GATKE CORPORATION

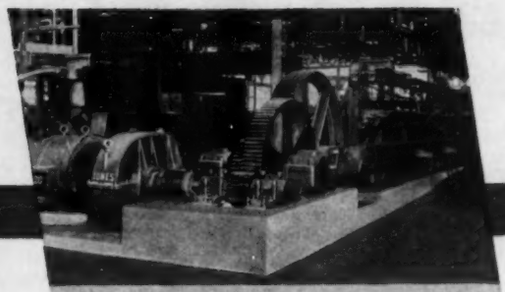
228 N. LaSalle St., Chicago 1, Ill.

GATKE Bearings are moulded to machined accuracy in all shapes and sizes, in three general types: GATKE LUBRITEX Bearings for grease or oil lubrication—GATKE HYDRO-TEX Bearings for water lubrication—and GATKE GRAFITEX Bearings for some self-lubricated applications.

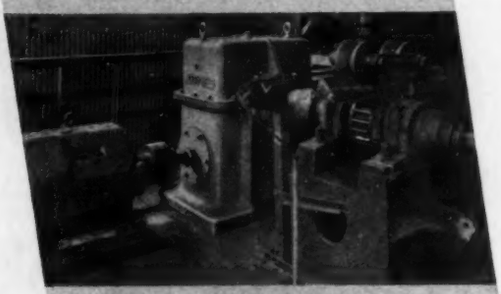
imaxing 30 years' Progress in making things to do the Job BETTER

KEEP GOING

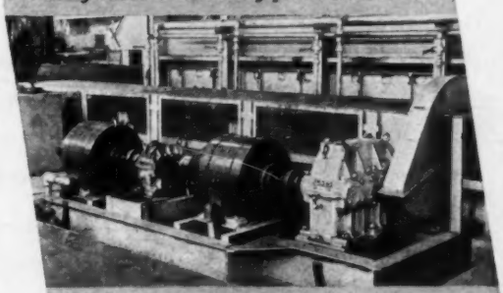
. . . WITH JONES



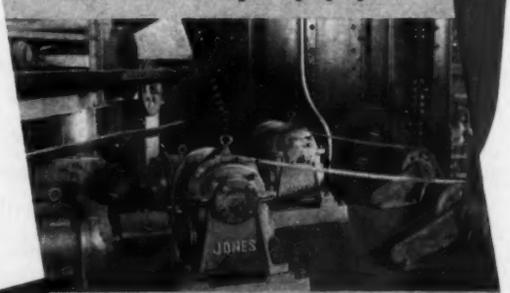
Jones Herringbone Speed Reducer driving steel tube mill draw bench. Gear casings removed to show proportions of spur gear drive to head shaft.



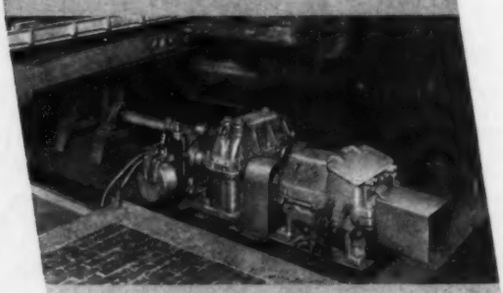
Jones Worm Gear Speed Reducer operating cover of warming pit in steel mill.



Jones Herringbone Reducers operating furnace in steel mill. Drive consists of two motors with single type and double type reducers coupled in series in order to obtain two widely varying speeds.



Two of a battery of 10 Jones Worm Gear Door Hoists for operating open hearth furnace doors.



Jones Herringbone Reducer operating sheet mill tilting drive on feeder table.

• In every phase of the steel business today, whether it is production or fabrication, the cry is "keep going".

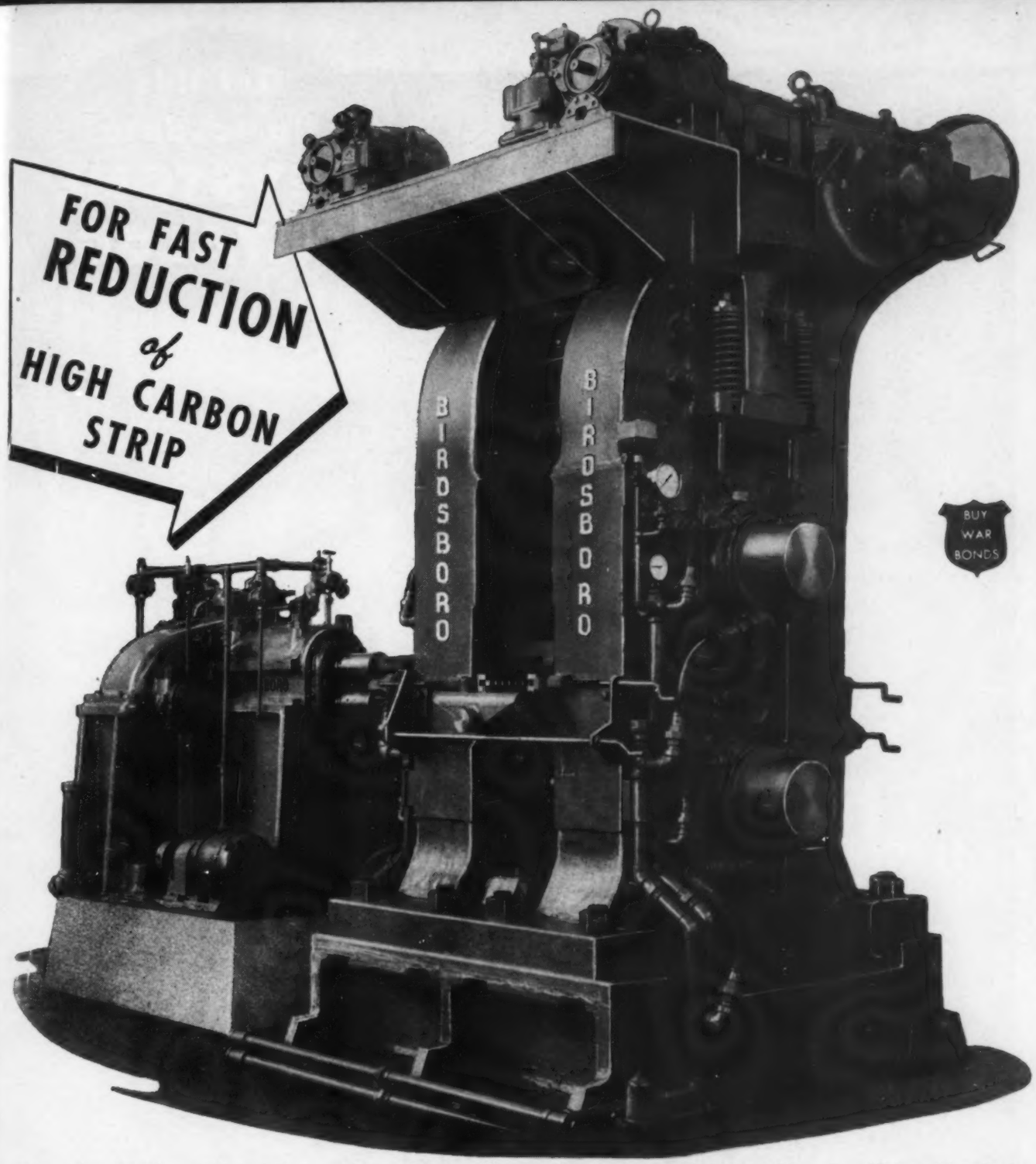
The Jones organization, too, is busy manufacturing the various types of speed reducers and other transmission products that are so essential for drives in every type of plant — drives that are so necessary in maintaining peak production.

We picture here some typical Jones drives that have seen years of service in the steel industry. They have been called upon to take a lot of punishment and they will stand the gaff for a good many years to come.

W. A. JONES FOUNDRY & MACHINE COMPANY
4431 Roosevelt Road, Chicago 24, Illinois

Jones

HERRINGBONE — WORM — SPUR — GEAR SPEED REDUCERS • PULLEYS • GEARS • V-BELT SHEAVES • ANTI-FRICTION PILLOW BLOCKS • FRICTION CLUTCHES • FLEXIBLE COUPLINGS



This modern Birdsboro 4-high single reversing cold strip mill reduces high carbon strip (1.30 carbon) from ⅛" down to finished thickness of .004" to .072" in widths up to 9" at speeds ranging to 750 f.p.m.

The particularly heavy housings incorporated in this new Birdsboro cold strip mill insure holding gauge accurately. Screwdowns are motor operated with indicators. This mill is equipped with antifriction bearings in screwdown, work rolls, back up rolls and throughout drive. In addition, this mill is furnished complete with hardened and ground alloy steel rolls and with motor operated oil circulating system.

Birdsboro engineers would like to discuss your steel mill equipment problems with you. Birdsboro specializes in building heavy steel mill equipment to fit individual needs. Write today for details.

BIRDSBORO STEEL FOUNDRY & MACHINE CO • BIRDSBORO, PA.

BIRDSBORO

STEEL MILL EQUIPMENT

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Up-to-date
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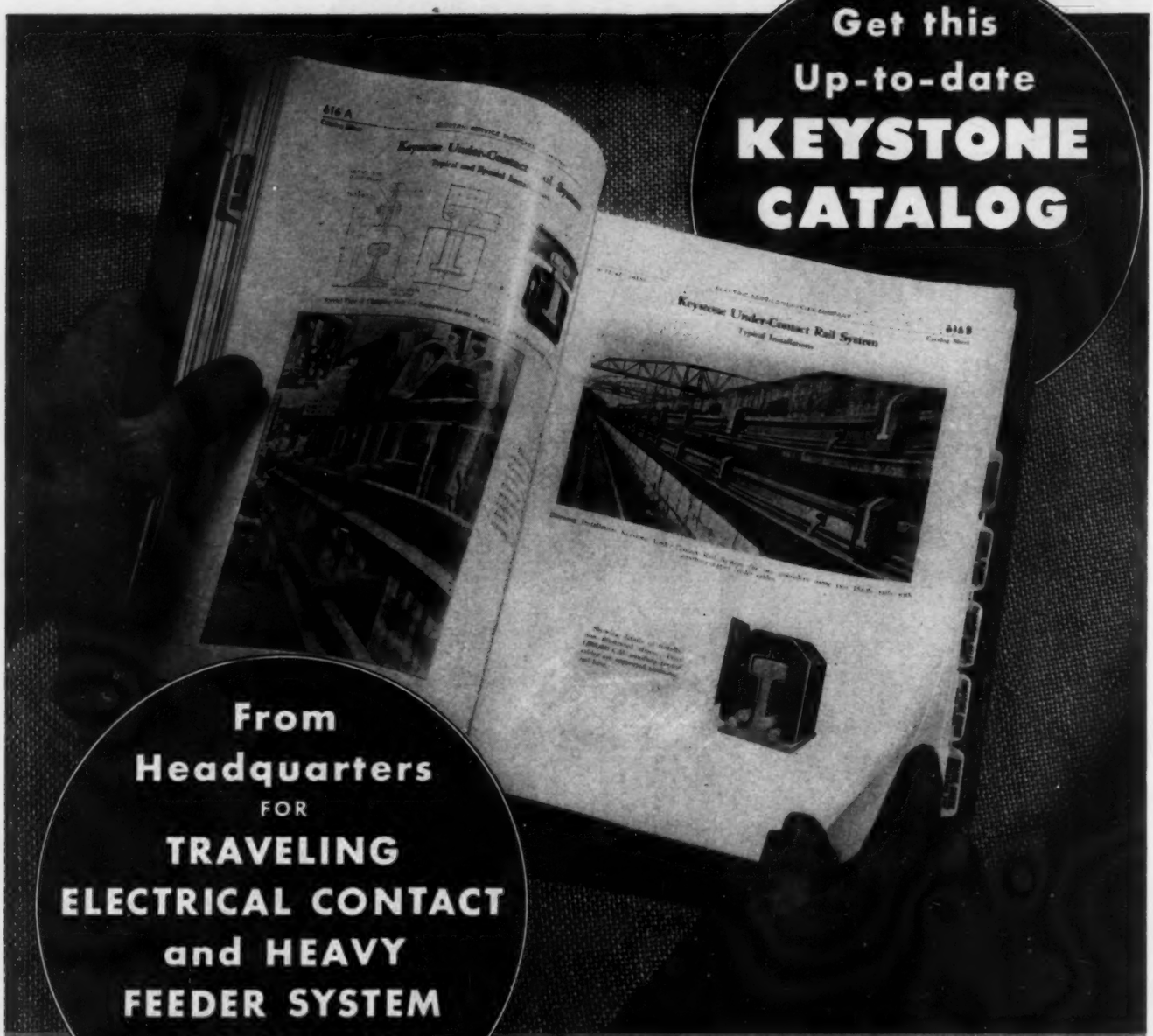

From
Headquarters
FOR
TRAVELING
ELECTRICAL CONTACT
and HEAVY
FEEDER SYSTEM
MATERIALS

This catalog will help you. Contains 500 pages listing hundreds of items necessary to maintain crane runways and electrical feeder systems. Ask for catalog "Keystone Electrical Material" if you do not have it in your files.

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Former Name—Electric Service Supplies Co.

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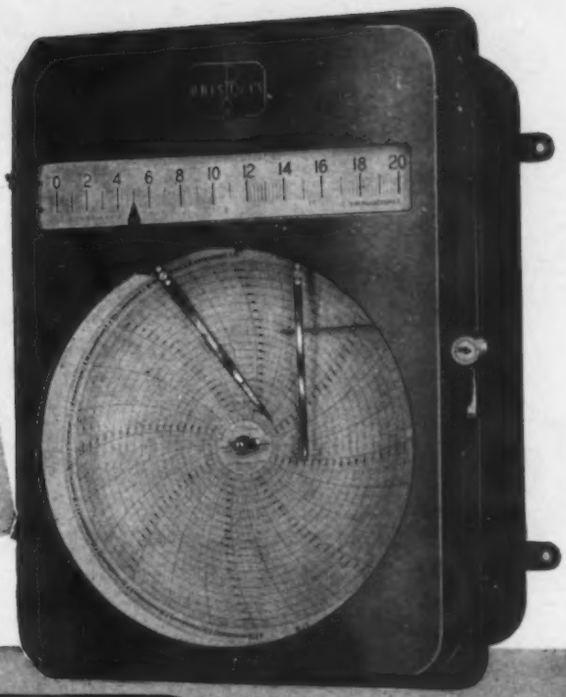
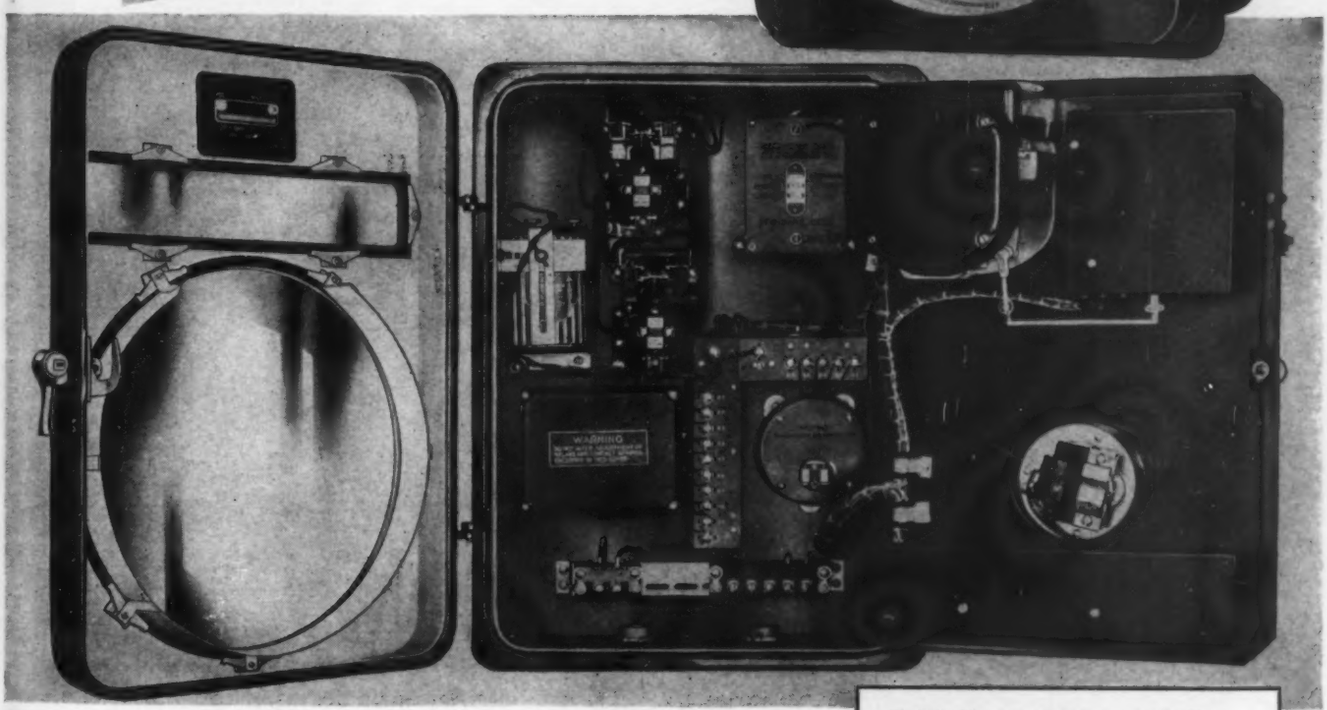
Bristol's PYROMASTER

A Self-balancing Potentiometer for Recording, Indicating and Controlling Industrial Processes

REDESIGNED EMBODYING NEW FEATURES

1. Hinged panel for accessibility.
2. Standard Cell for accuracy.
3. High-torque motor for ruggedness.
4. Totally enclosed relays and galvanometer.
5. Enclosed tarnish-resistant slide-wire.
6. Large easily read straight-line scale.





Pyromaster Pyrometer Electric-Type Controller, door open and panel swung out

ALL PARTS ACCESSIBLE: All parts of the Pyromaster are accessible even when the instrument is in full operation. The dial and recording mechanisms are mounted on the front of a hinged reinforced steel panel, which can be swung out of the case as shown above. The slide wire and potentiometer mechanism and, in the case of controllers, the control mechanism are mounted on the back of the panel. Each part or unit can be serviced in place or removed without disturbing any other part.

Bristol's PYROMASTER Pyrometers are available in the following types of instruments for temperatures up to 3600° F.

Electric-Type Controllers
Air-Operated Controllers
Single-Pen and Two-Pen Recorders
Dial Indicators
Time-Temperature Controllers
Radiation Pyrometers

Complete facts in Bulletin P1200. Address 123 Bristol Road

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Bristol's Instrument Co., Ltd.
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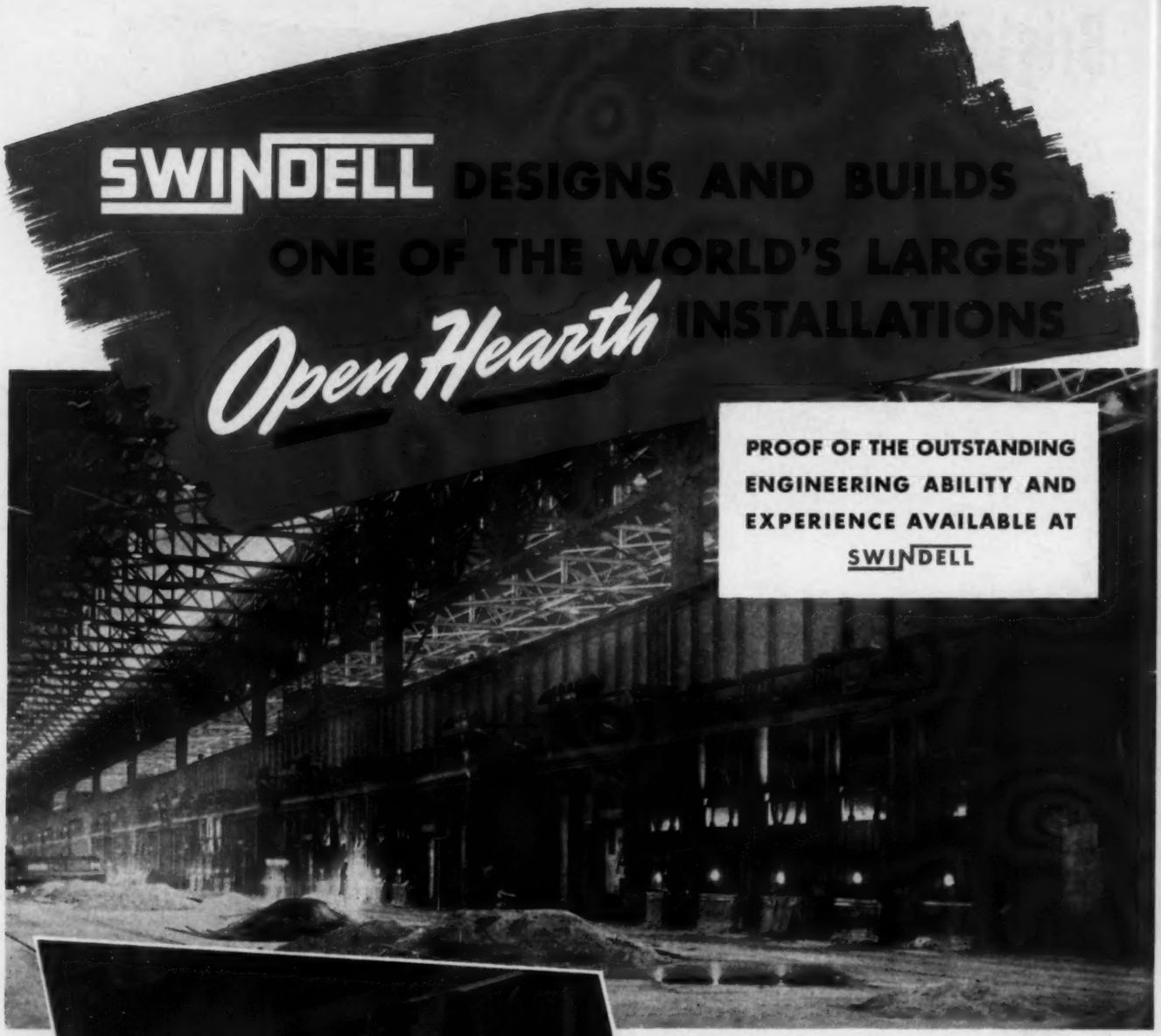
SWINDELL DESIGNS AND BUILDS ONE OF THE WORLD'S LARGEST *Open Hearth* INSTALLATIONS

PROOF OF THE OUTSTANDING ENGINEERING ABILITY AND EXPERIENCE AVAILABLE AT SWINDELL



Open Hearth floor and three of the many furnace doors at the Carnegie-Illinois Steel Company at Homestead.

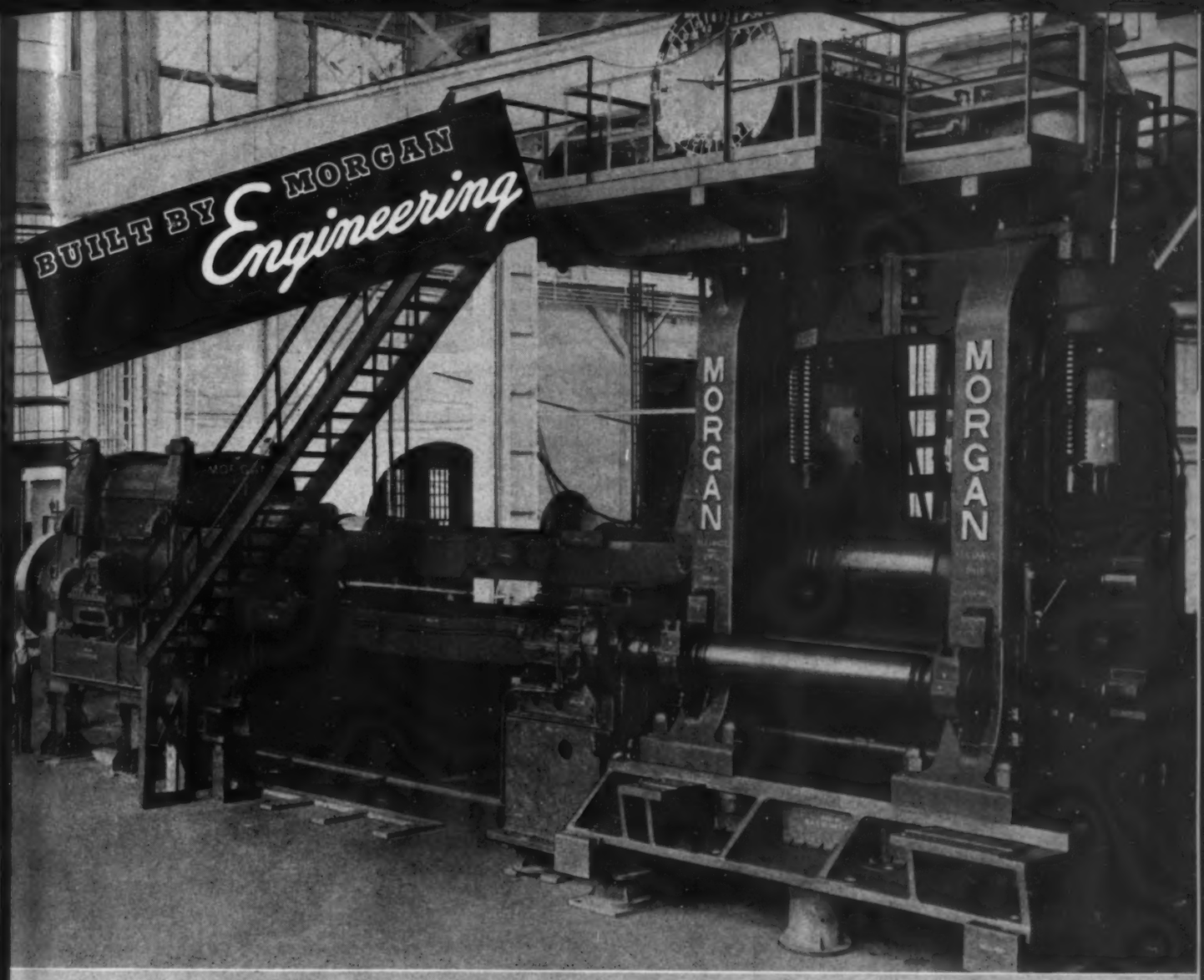
The investment with a GUARANTEED future
BUY MORE WAR BONDS!

Every Swindell installation embodies these satisfactory performance features:

- *Advanced engineering design*
- *Complete accuracy of control*
- *Continuous, maximum production*
- *Low operating and maintenance costs*
- *Designed for labor minumum*

Swindell engineers will gladly discuss furnace modernization, or new construction, with Steelmakers, anytime, anywhere.

SWINDELL-DRESSLER *Corporation*
DESIGNERS AND BUILDERS OF MODERN INDUSTRIAL FURNACES
PITTSBURGH, PA.



MORGAN "36" TWO-HIGH BLOOMING MILL

Above is shown a Morgan 36" Two-High Blooming Mill on erecting floor. Housings are one piece steel castings of the closed top type. Top roll balance is of the counterweight type. Top roll lift sufficient for rolling 42" wide slabs. Manipulator is of the overhead type, compact and accessible. Tables are of heavy design, equipped with anti-friction bearings.

With this Mill was furnished Auxiliary Equipment as follows — Front and Rear Tables with Manipulator — Approach Table — Ingot Buggy — Runout Tables — Slab Shear with Gauge — Crop Hoist — Pushers — Conveyor — Skid Bed and Furnace Tables.

THE MORGAN ENGINEERING CO.

ALLIANCE, OHIO. 1420 Oliver Building, Pittsburgh

DESIGNERS • MANUFACTURERS • CONTRACTORS • BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

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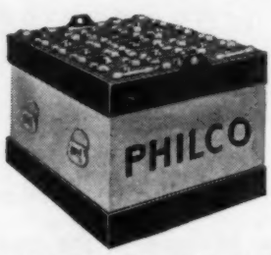
Philco is ready, *today,* with the advanced high-capacity battery performance and long-life economy you'll need in your post-war operations. The complete Philco post-war line includes modern Storage Batteries for all motive power and stationary needs. It will save you dollars in depreciation, up-keep and maintenance costs to specify Philco. Let us send you the latest Philco Battery catalogs of types for your special requirements. Philco Corporation, Storage Battery Division, Trenton 7, N. J.

THE NEW PHILCO "THIRTY"—An outstanding post-war product for industrial trucks is the new Philco "Thirty" Storage Battery that gives 30% longer life and is identified by its distinctive red top. Now available in certain types and limited quantities.

Philco Telephone and Control Battery Cell with Floté element



Typical Philco Electric Industrial Truck Battery in Steel Tray

Specify PHILCO STORAGE BATTERIES

For 50 years a leader in Industrial Storage Battery Development

NEWS SUPPLEMENT February, 1945

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Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

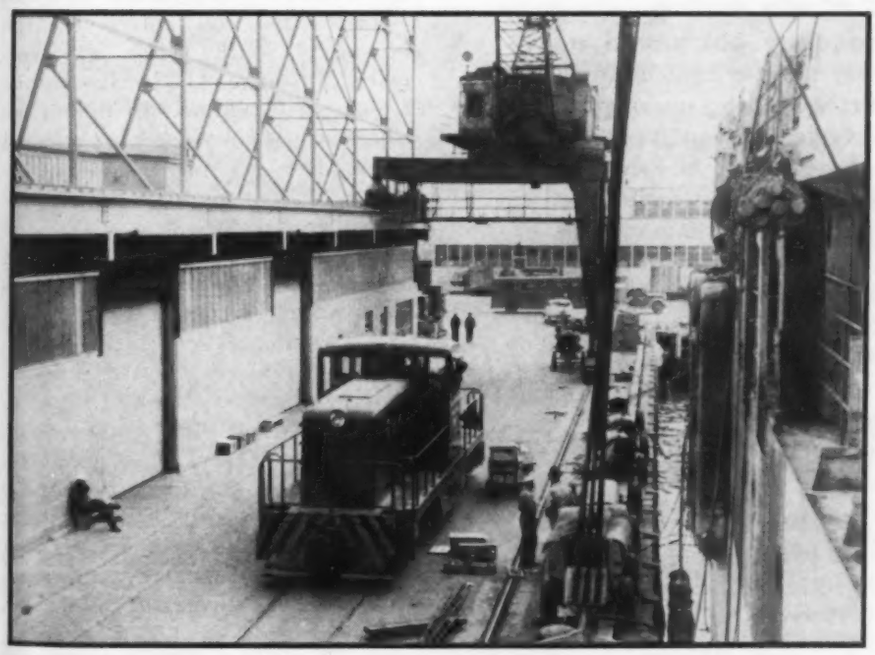
REPUBLIC ATTAINS FINE SAFETY RECORD

Intensified safety work and improved working conditions in the plants and mines of Republic Steel Corporation brought about a 46.4 per cent reduction in the accident severity rate and a reduction of 20.03 per cent in the accident frequency rate in 1944, according to an announcement by C. M. White, vice president in charge of operations.

In the company's 1944 safety competition, in which all plants and mines participated, first place in the steel plant group was won by the Warren district of Warren, Ohio, with a severity rate of .93 and a frequency rate of 3.34. The Berger Manufacturing Division of Canton, Ohio, took first honors in the manufacturing divisions, with a record of no accidents and a greater number of manhours worked, while the Southern Coal Mine Division of Birmingham, Alabama, ranked first in the coal mining operations. The Northern Ore Mines of Duluth, Minnesota, won top honors in the ore mine group. Republic Safety Awards, emblematic of the corporation's slogan, "Production with Safety," will be presented each of these leaders.

Recognition was also given the seven industrial plants and mines in Republic Steel which operated during the entire year without a lost-time accident. These operations to be honored are: Bolt and Nut Division, Gadsden, Alabama; St. Paul-Day Ore Mine, Keewatin, Minnesota; Lake Erie Limestone Company, Hillsville, Pennsylvania; Trucson Steel Company, Gadsden, Alabama; Warehouse Division, Youngstown, Ohio; Culvert Division, Canton, Ohio; and the Truscon Erection Division of Youngstown, Ohio.

DIESEL-ELECTRICS KEEP WAR GOODS MOVING



Five diesel-electric locomotives, built by General Electric and ranging in size from 44 to 80 tons, are operating almost 24 hours a day, seven days a week, at the U. S. Naval Supply Depot, Oakland, California.

Used to the full extent of their 98.8 per cent availability, these diesels are doing the work of eight steamers. Since December, 1943, when they were placed in service, the two 80-tonners have required no maintenance other than a routine 2-hour weekly servicing. Maintenance for the others has been equally favorable. Operating costs have also been lower, with the 80-tonners handling 50 per cent more work at a fuel cost 75 per cent below that of steamers.

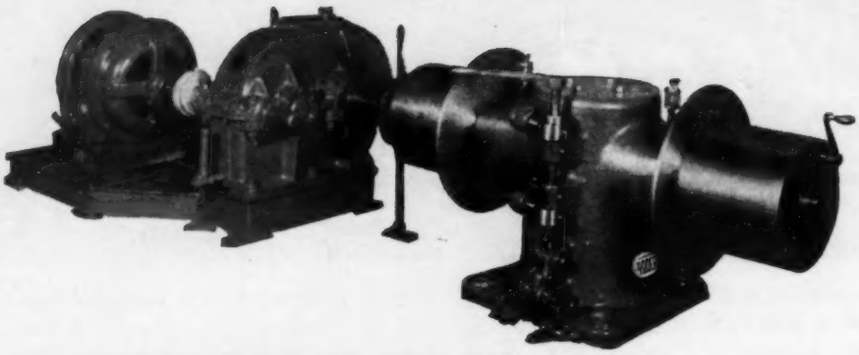
SELF-LUBRICATING BEARING STOCK RANGE WIDENED

▲ To aid the war effort, addition of several dozen new sizes of cored and solid bar stock in Oilite materials has been announced by Chrysler Corporation's Amplex Division. Wide acceptance and tremendously increased use of the self-lubricating Oilite bronze and ferrous base Super-Oilite in bar form were given as the reasons for the expanded size list. The new sizes embrace a range of $\frac{3}{8}$ in. to more than 12 in. in diameter. Heavy demand of Oilite and Super-Oilite materials has been laid to their obvious advantages over cast cored and bar stock. Most important advantages of the Oilite bar stock are the features of self-lubrication and greater load carrying capacities.

The broad-scale war production use of cored and bar stocks stems mainly from their fulfillment of three vital requirements. With a bin of various sizes of self-lubricating cored and solid bars on hand a plant is equipped to make rapid bearing replacements on a breakdown, provide the necessary replacement for a faulty bearing installation, and give the engineer or production man the means of quickly securing a bearing for experimental needs.

It has been estimated by Chrysler's Amplex Division that their line of

COIL HANDLING



EQUIPMENT By *Yoder*

DEVELOPMENT of coiled strip in a constantly increasing variety of widths, gauge and material has been an important factor in the advancement of high speed production in stamped, punched, drawn and roll-formed metal products. Yoder has specialized in the engineering and building of special handling equipment from the early days of strip making.

Today Yoder builds coil handling equipment as varied as industry's needs, from simple ball-bearing coil boxes to cone type uncoilers with drag generators and from simple stock reels to huge tension reels for steel mill use. The patented double-swivel type recoiler, shown above, which handles single or multiple coils up to 6,000 pounds, is made so that coils can be unloaded from one side while the other is recoiling . . . The coil box at right is the simplest form made, ball bearing, easy to load, compact, suitable for serving a wide variety of strip-fed production machines. There are many other types.

These machines may be had with Yoder pinch-roll feed stands, levellers, edge trimmers or as integral parts of complete Yoder-built slitting or roll-forming lines. If your coil handling need is special, Yoder can engineer a unit for you, based upon the most complete experience in the industry.

For engineering consultation or product information write to

ENGINEERING YODER MANUFACTURING

The YODER COMPANY

METAL WORKING PRODUCTION MACHINERY

5526 WALWORTH AVE., CLEVELAND 2, OHIO

cored and bar stock is saving war plants thousands of man hours a month by providing quick and lasting bearing replacements for machines that otherwise would be shut down by recurrent bearing failures.

Although Oilite differs from cast materials in that it is made from metal powders and impregnated with oil, the cored and bar pieces are machined just like a cast bearing.

Oilite cored and solid bars are now being stocked in all major cities of the United States and Canada. For complete information on Oilite cored and bar stock write for a new booklet, to Amplex Division, Chrysler Corporation, 6501 Harper Avenue, Detroit 31, Michigan.

WIRE COMPANY SETS MANY PRODUCTION RECORDS

▲ Faced with the need for more and more material to furnish our armed forces with the tools for victory, the men and women of American Steel and Wire Company, United States Steel Corporation subsidiary, met the challenge and broke 435 production records during the year 1944. This brings the number of records smashed since Pearl Harbor to 2,289.

For the third consecutive year, the company's South Works at Worcester, Massachusetts, led the parade of increased volume production by surpassing 94 previously established marks. This one plant alone has a total of 538 records to its credit since December 7, 1941.

Second in line was the Steel and Wire Works at Donora, Pennsylvania, which broke 78 records last year, bringing its war total to 363. New Haven, Connecticut, and Joliet, Illinois, were tied for third place in record smashing performances, each chalking up a total of 54 to attain "since Pearl Harbor" marks of 159 and 185, respectively. The Duluth, Minnesota, operations and Cuyahoga Works in Cleveland each broke records 37 times during 1944. Trenton, New Jersey, racked up 21 new marks, while Waukegan, Illinois, with 16, and Newburgh Works in Cleveland, with 13, were close behind.

The Rankin, Pennsylvania, plant smashed 12 old records followed by Donora Zinc Works with 10, Consolidated Works in Cleveland with 6, and American Works, also in Cleveland with 3.

MERCURY ARC CONVERTERS FOR 1000-2000 CYCLE POWER

▲ Development of a new mercury arc converter which fills out the low frequency range of electronic equipment required in the growing field of induction heating applications is announced by the Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin.

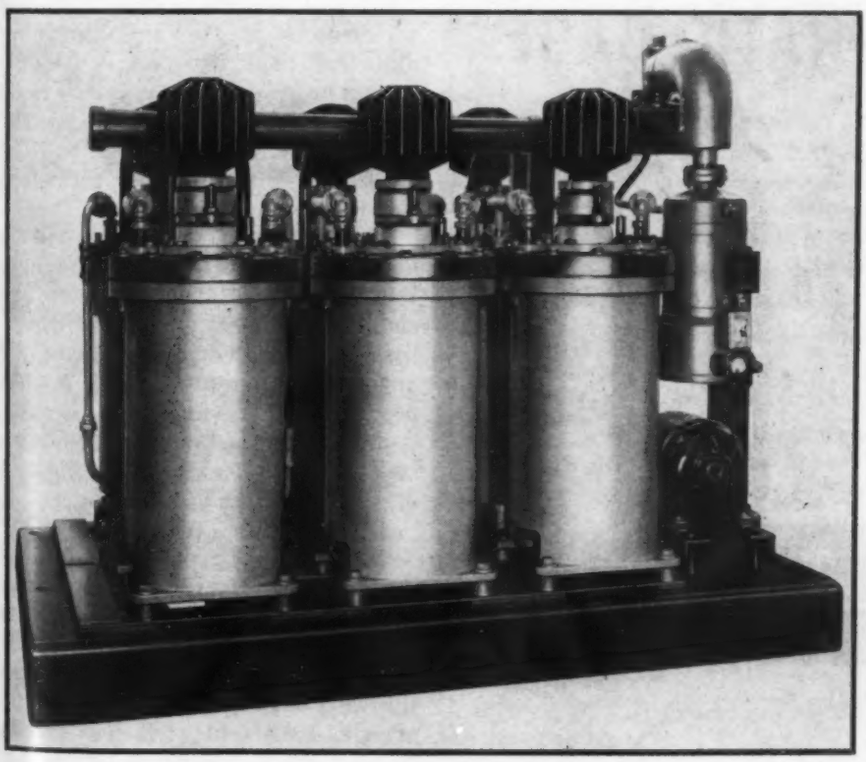
Designed for the purpose of electronically changing power at commercial frequencies of 60 or 25 cycles into 1000 to 2000 cycle power, the mercury arc type of frequency changer is particularly suitable for supplying power for forging, melting, and metal treating applications where large masses of metal or metal parts must be efficiently heated with this power at kilowatt capacities of 250, 500, 1000 and higher.

Two highly successful applications of the new converters have been made in the past year, one being a 300 kw unit in a forge plant, and the other a 250 kw unit in use in the melting section of a brass foundry.

In months of operation, these Allis-Chalmers mercury arc frequency changers have performed at higher full load and much higher partial load efficiencies than is possible with other types of converters for like frequencies; and operating and maintenance costs of mercury arc converters have proved to be much lower. The units are quiet in operation and require no ventilation or air-filtering, since they are water-cooled. In addition, high capacity mercury arc converters offer no vibration problems, making heavy and expensive foundations unnecessary.

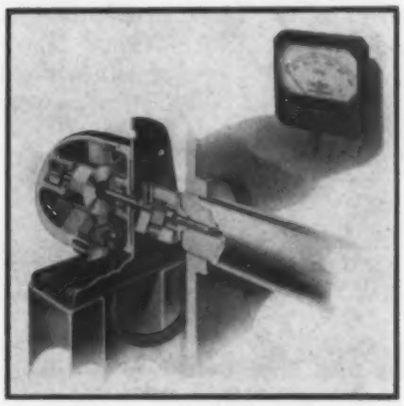
Already a familiar machine, the mercury arc rectifier is involved in the utilization of nearly 10 per cent of the electrical energy generated in the United States. Entry into the induction heating field with the mercury arc converter completes the Allis-Chalmers line of electronic type induction heating equipment, since the company is also building high vacuum tube equipment for the higher frequencies.

Mercury arc frequency changers for converting commercial frequencies into 1000-2000 cycles are well suited for forging, melting and heat treating with induction heating.



INDICATOR FOR REMOTE SPEED MEASUREMENT

▲ Wherever machinery turns, there is the need for reliable, continuous, visual speed indication to gain advantages in lower costs, lengthened life for machinery and tools, improved quality, and in the assurance of safe operation. Now a sturdy, accurate, low-cost electric speed indicator, developed by the Reliance Electric and Engineering Company, Cleveland, Ohio, makes it possible to determine and to set proper operating speeds in a broad new field of applications, where the installation of such instruments was heretofore not economically feasible.



The Reliance Electric speed indicator, which gives accurate readings of speeds from 100 rpm to 5000 rpm, consists of two units. The pick-up unit, a miniature six-pole alternator with a permanent magnet rotor, is mounted on the shaft whose speed is to be measured. The indicator, a permanent magnet, moving-coil type, meters the pick-up output on a 3¾ in. scale which covers 95 degrees of arc. The resistance of the indicator has been made sufficiently high, so that the size or length of the leads connecting the units will have no effect on accuracy, and the indicator may be located at any distance from the pick-up unit. The indicator is not affected by other magnetic material, and there is no loss of accuracy due to length of service.

Reliance's 30 years' experience with variable-speed machinery drives has shown company engineers the need for such a compact, long-life production indicator, and they have built the utmost in sturdy simplicity into the mechanism.

Instantaneous and continuous speed indication is independent of the direction of rotation of the shaft. Pick-up windings are stationary, and there are no commutators or slip rings. No conduits are required, and lifetime lubrication further simplifies maintenance.

Special attention to flexibility of use has been given, too, in the physical design of the indicator. Fool-proof shaft coupling is provided, and the indicator may be bracket or panel mounted.

LARGE MALLEABLE IRON FOUNDRY COMPLETED

▲ What is believed to be the largest malleable iron foundry built in the past 17 years has been completed by The Rust Engineering Company for Lake City Malleable Company at Ashtabula, Ohio, Rust officials said recently. The facilities are financed and owned by Defense Plant Corporation. The 3½ acre structure which makes Lake City Malleable one of the largest operators in the country, was authorized to fill the need for malleable parts for tanks and trucks, both military and those being built for expanded domestic transport.

All glass sidewalls, oriented to admit maximum light and at the same time eliminate glare, and air conditioning and dust collection systems assuring a degree of cleanliness unusual in foundry work, are notable plant features.

Electrically operated throughout, the entire production area is served by crane and monorail with no lifting required by labor, allowing employment of skilled labor, grinders and molders, almost exclusively.

Operations are on the following straight flow basis:

1. Storage facilities for raw materials.
2. Duplex melting system of cupolas and air furnaces.
3. Modern molding and casting system embodying power conveyors.
4. Modern casting and sand handling facilities.
5. Electrically heated elevator type annealing furnace.
6. Modern layout of cleaning and finishing equipment.
7. Shipping facilities.

This production line is plotted on the basis of carefully estimated data of storage of supplies, labor, and equipment capacity, to maintain a continuous flow of castings.

Rust designed and constructed the plant and erected its equipment. An important post-war, as well as war, future is anticipated for the foundry since a large part of malleable output normally goes to the automobile industry.

ATTACHMENT WIDENS TRUCK APPLICATION

▲ The Baker Industrial Truck Division of The Baker-Raulang Company, Cleveland, Ohio, announces an attachment designed by Baker engineers for fork trucks to move railway car wheels mechanically and safely. This attachment fits a standard Baker fork truck and may be quickly removed when the truck is to be used for handling pallets or for some other purpose. The attachment handles wheels of any diameter and eliminates the need for skilled wheel rollers and the element of danger in case the wheel should get out of control.

The attachment consists of a hinged hoe-like clamp which engages the top of the farthest wheel. The clamp arm is raised to clear the wheels by a lever located convenient to the operator and may be latched in that position. The arm and lever assembly is mounted on a bracket which slips onto the top of fork backs and is held in position by its own weight.

To pick up a load of wheels, the clamp is raised by pulling and latching the lever. The forks are then run under the wheels. If the wheels do not tilt approximately alike, they may be straightened up by forcing one against the other with the bottom edge of the attachment bracket, which is turned

For better steel.. and more of it
TELLS YOU AT A GLANCE
★AMOUNT OF AIR FLOW AND FUEL FLOW
★PERCENTAGE OF AIR EXCESS OR DEFICIENCY
the HAYS VISIO-RATIO GAGE
IT'S A GOOD "steel man"—this truthful reporter of combustion facts. It's infallible—made to be.
It saves man hours—does away with time-consuming calculation of air excess or deficiency and all need for experimental adjustments.
It saves fuel—indicates instantly any faulty proportion of air and fuel.
It saves material—makes for greater uniformity, and for less spoilage.
It helps you get better steel—and more of it.
ADVANTAGES
Advantages of Hays centralized control of open hearth furnaces are set forth in Publication 43-586. Useful literature—better send for it.
The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

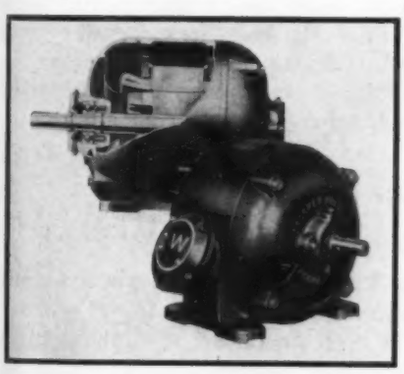
over in a lip. The handle is next unlatched and the arm lowered. The forks may then be raised, picking up the wheels in the same tilted position in which they were stored.

A 6000-lb capacity truck handles one to six wheels on 48-inch forks. The arm will accommodate 36-inch passenger car wheels or smaller ones, as well as the standard 33-inch freight car wheels. One or two wheels can be handled as well as a full load, a pin stop preventing their tipping.

The forks — without removing the car wheel clamp attachment — will handle a capacity load of axles or it will handle two axles with wheels mounted. The same fork truck with an interchangeable boom attachment will unload wheels from gondolas working from a dock or from track level. If wheels are shipped in box cars they may be loaded and unloaded by the fork truck with car wheel attachment.

NEW HOUSING DESIGN PROTECTS MOTOR

▲ A new motor, combining the surplus capacity of the conventional open motor with protection against dripping liquid, falling metal chips and other foreign matter, has been developed by the Crocker-Wheeler Division of Joshua Hendy Iron Works at Ampere, New Jersey.



Rated 40 C rise, full-load continuous duty, with a 15 per cent service factor, Protected-Type motors provide added protection at open motor prices. At present, these motors are available in sizes up to and including the 284 frame. Mounting dimensions conform to the standards of the National Electrical Manufacturers Association.

There are no openings in the frame or shields above the horizontal center line. This, together with the shielded construction of the ventilating openings, makes Protected-Type motors suitable for machine tool and similar applications where other types of enclosures have been required in the past.

Centrifugal seals permit use of softer grease for better lubrication and longer bearing life. The company's alucast rotor construction, in which the bars, fans and end rings are cast in one operation from aluminum alloy, is employed.

Other features of these many-purpose motors include: heavy cast frame construction, coils protected by vinyl acetal insulation, interchangeable front and rear shields, and specially designed guides for directing cooling air over all surfaces.

PRODUCTION RECORDS MADE BY ARMCO

▲ While newspapers were filled with reports of absenteeism and war plants shut down by holiday hangovers, the East Works plant of The American Rolling Mill Company broke production records right and left.

During the Christmas to New Year's week, the open hearth department made 169 more tons of steel than during any like period in the plant's history, L. F. Reinartz, Armco works manager reported. "This record was made during a time when our scrap and other raw materials were coated with ice and hard to handle. The roads and streets were also slippery with ice, yet our people got to work and the record shows they worked effectively."

Reinartz also said that No. 5 open hearth furnace established a new all-time monthly production record in December, making 384 more tons of steel ingots than ever before.

The cold strip annealing department also set up an all-time monthly production record in December.

Several new yearly production records at Armco came to light with the end of 1944. The East Works blooming, bar and strip mill established a record production in 1944. When the year ended this department had exceeded all previous yearly records by 40,266 tons. Another record-breaking department was the cold strip mill. The men in this department rolled 66,735 more tons of steel during 1944 than in any previous year. The electric furnaces of the alloy department made 794 more tons of alloy steel in 1944 than in 1943, the previous high.

LUBRICATION IS INDUSTRY'S PRIME ESSENTIAL

The "all-out" production of the war period has not only proven the importance of proper lubrication but has effectively demonstrated the superiority of LUBRIPLATE Lubricants. Even the most confirmed skeptic must admit that when two surfaces do not touch, there can be no appreciable wear. The separating film of LUBRIPLATE is tougher. That is why LUBRIPLATE Lubricants impart longer life to shafts, bearings, and gears. LUBRIPLATE has qualities not possessed by conventional lubricants.

LUBRIPLATE
Lubricants definitely reduce friction and wear to a minimum. They lower power costs and prolong the life of equipment to an infinitely greater degree. LUBRIPLATE arrests progressive wear.

LUBRIPLATE
Lubricants protect machine parts against the destructive action of rust and corrosion. This feature alone puts LUBRIPLATE far out in front of conventional lubricants.

LUBRIPLATE
Lubricants are extremely economical for reason that they possess very long life and "stay-put" properties. A little LUBRIPLATE goes a long way.

Write for a booklet, "The LUBRIPLATE Film", written especially for your industry.

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UNIT DEMAGNETIZES TOOLS AND SMALL PARTS

▲ A new line of demagnetizers for completely demagnetizing magnetically soft materials, such as common irons and steels, and partly demagnetizing permanent magnets such as alnico, has been announced by the Special Products Division of the General Electric Company. The new demagnetizers are designed to demagnetize tools, drills, and punches in order to prevent excessive heat and wear caused by the adherence of magnetic chips. They are also desirable for demagnetizing various machined parts, thus releasing fine adhering particles which often cause severe wear and impair accuracy and appearance. In addition, they can be used to adjust and stabilize the magnetic flux in permanent-flux assemblies for such applications as electric instruments and control devices.

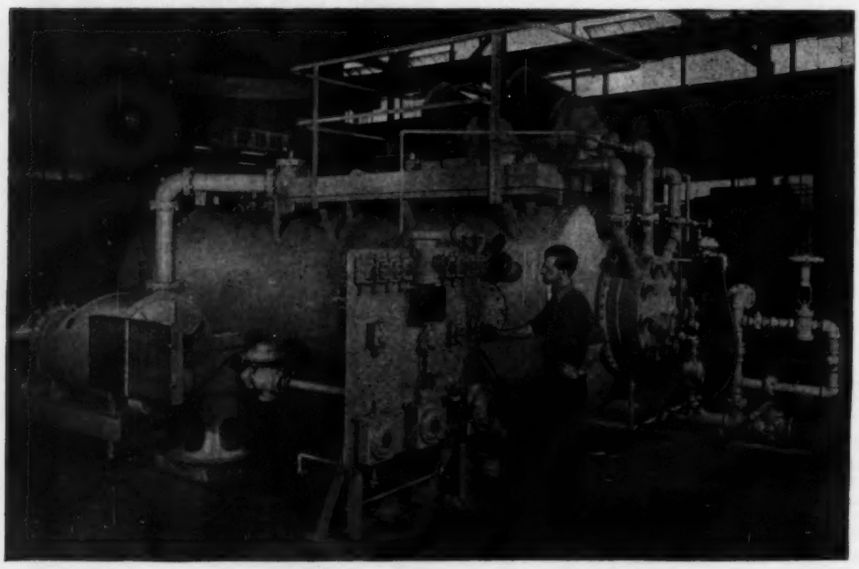
Consisting of a cylindrical air-core coil, mounted in a sturdy stand at a convenient 45 degree angle, these demagnetizers are available in a 4-in. size, rated 115 volts, 60 cycles, a-c, and in 8- and 12-in. sizes, rated 220/440 volts. Long flexible leads, for connection to the power line, are furnished with the 4-in. size, while a small connection box behind the coil of the larger sizes accommodates standard electric conduit.

In operation, rated voltage is applied and the material to be demagnetized is either passed directly through the coil or placed in its center and slowly withdrawn about two feet along its axis. At that point the magnetic field is negligible, and the material is then demagnetized. For continuous operation, nonmetallic conveyor belts can be run through the coil, provided the parts being demagnetized are neither in metal containers nor in contact with each other, so as to cause shielding.

LUKENS OFFERS PLATE WEIGHT CALCULATOR

▲ A combination steel plate weight calculator and steel plate size selector has been developed by Lukens Steel Company, Coatesville, Pennsylvania, for use by engineers and users of steel plate or equipment made of steel plate. The device is believed unique because of the wide range of gauges, widths and lengths of steel plate, for which weights can be calculated on it.

With the steel plate weight calculator, which operates somewhat like a slide rule, the theoretical weight of any steel plate can be determined quickly from 10 to 200 inches in width and from 3/16 to 6 inches in thickness. With the steel plate size selector the longest and widest steel



Specify INERTS or NITROGEN by KEMP

FOR PURGING — FOR BLANKETING — FOR PROCESSING

Kemp Inert Gas Producers and Kemp Nitrogen Generators are available in standard models with capacities ranging from 1000 to 100,000 cubic feet per hour—larger sizes and special models built to order.

Features on all models: Flexibility—gas production automatically responds to demand at any rate up to 100% of capacity, thus frequently eliminating need for gas-holders or accumulators to meet peak loads. Safety features include: electric ignition, safety-pilot, soft heads, and automatic shut-down in the event of (a) burner outage, (b) cooling water failure, (c) power failure, (d) fuel gas failure, and safety purging of unit on shut-down or before starting. Units may be furnished for either semi- or fully-automatic operation.

Safeguard against explosion hazards from flammable vapors or explosive dusts with low-cost Inerts or Nitrogen from Kemp Generators. Write for engineering data, recommendations and quotations.

Ask For Bulletin 901.3

OTHER KEMP PRODUCTS

Nitrogen Generators ▪ Inert Gas Producers
Atmos-Gas Producers ▪ Immersion Heaters
Flame Arrestors for vapor lines, flares, etc.
The Industrial Carburetor for premixing gases
Submerged Combustion Burners
A complete line of Industrial Burners, and Fire Checks.

Address The C. M. Kemp Mfg. Co. 405 E. Oliver St., Baltimore-2, Maryland.

KEMP of BALTIMORE

plate obtainable for any desired thickness can be determined.

Included with the selector is an imprinted table giving decimal equivalents and weights which will be of value to users of the device.

INSTRUMENT COMPANY CHANGES HANDS

▲ The C. J. Tagliabue Manufacturing Company, pioneers in the manufacture of Industrial Control and Laboratory Instruments, has sold its assets, including goodwill, name and patents, to the Portable Products Corporation of Pittsburgh, Pennsylvania.

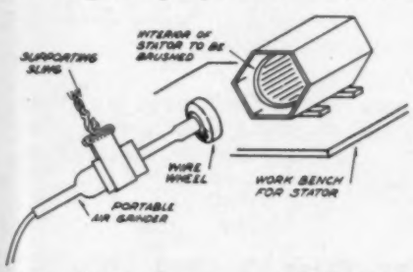
The progressive research and development policies in electronic and mechanical instrumentation which for so many years have characterized the Tagliabue organization will be continued vigorously under the new management and personnel that has made TAG an outstanding name in industry.

The business will be operated as a separate division of the Portable Products Corporation. Among the interests of the latter are manufacturing plants in Newburgh, New York, Philadelphia and Pittsburgh, Pennsylvania.

POWER BRUSHING SPEEDS MOTOR PRODUCTION

▲ Manufacturers of critically-needed electric motors are making many uses of power brushing to maintain production for the armed services as is exemplified by one of the nation's largest manufacturers of electrical equipment.

One of the interesting applications is in cleaning insulating varnish from the interiors of stators, according to a report received by The Osborn Manufacturing Company, Cleveland, Ohio.

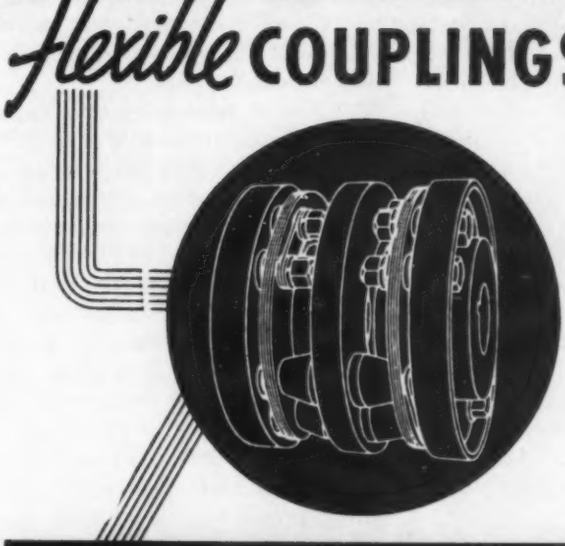


Usually stators are not dipped, but only the coils. The electrical equipment manufacturer has been using power brushing for the usual operations in removing insulating varnish as well as for other work. Other typical jobs for power brushing in making electric motors include removing small fins in slots of stators, rust and discoloration from hardened steel rotors, burrs and corners and removing coatings or lacquer where not wanted.

With past experience in mind, the manufacturer made power brushing part of the production process as soon as the new job requiring interior cleaning of the stator was set up in the plant. The method (see illustration) is to operate the brush in a portable air grinder hung on a sling. The stator is held stationary, either by a fixture or its own weight. With the brush operating at 3600 revolutions per minute, the operator pushes it into the paper.

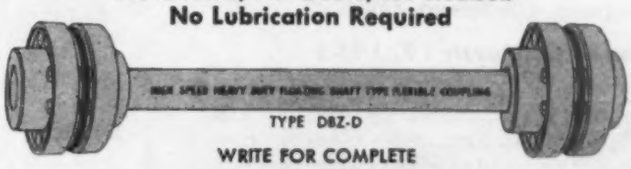
Power brushing enables the user to complete the stator cleaning in two or three minutes, making short work of the operation compared to more tedious cleaning methods. It has the further advantage of blending the metal surfaces by smoothing scratches and blemishes acquired during manufacture and handling.

THOMAS
Flexible COUPLINGS



Eliminate BACKLASH, FRICTION, WEAR AND CROSS-PULL
the four destructive evils of other types and makes of couplings that prevent a permanent care-free installation.

The Thomas All-Metal Coupling has:
No Chains, No Gears, No Rubber.
No Lubrication Required



WRITE FOR COMPLETE ENGINEERING CATALOG

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA

New Literature

▲ Just published by the Fluor Corporation is a new 20 page bulletin containing data for calculating cooling tower sizes, essential points in cooling tower selection and details of construction and operation of Fluor Aerator cooling towers. The bulletin is well illustrated, with photographs of typical installations, section drawings and performance charts. Available on request to The Fluor Corporation, Ltd., 2500 South Atlantic Boulevard, Los Angeles 11, California.

▲ The design, structural features and operating facilities of the Wilputte coke oven have been incorporated into a new catalog which is fully illustrated with cross sections, flow diagrams and views of recent installations.

The descriptions reflect the many advances that have been made to attain strength and easy and economical operation; to provide for expansion, prevent leakage and to keep pressure differentials low. The advantages of the underjet system and high and low burners for rich gas firing are dealt with fully.

Of particular interest is the chapter on the bus flues, ports and regenerator chambers, which are designed to equalize the flow of lean gas and air upward and products of combustion downward. The mechanical features described include the Wilputte self-sealing oven door and leveler door and the hydraulic door handling equipment.

Copies are available on request to the Wilputte Coke Oven Corporation, 40 Rector Street, New York 6, N. Y.

▲ The Torrington Company, Bantam Bearings Division, South Bend 21, Indiana, announces a revised bulletin, No. 105, entitled "High Capacity Ball Reciprocating Bearings," which covers a new list of recommended sizes. The high capacity ball bearing is designed for applications where ball bearing anti-friction qualities are desired in rotation, reciprocation, oscillation or combinations thereof. The construction employs a helix to separate the balls and retain them, thus permitting the use of approximately twice as many balls as the conventional sleeve type retainer. The bulletin also gives the operating capacities per row of balls for 100 rpm, based on an average life of 3,000 hours, and other pertinent engineering data. Copy of bulletin No. 105 will be sent on request.

▲ A recent release by the National Carbon Company is a 20 page bulletin which describes and illustrates a wide variety of carbon, graphite and "Karbate" products manufactured by the company for use in the chemical, metallurgical, mechanical, electrical and other industries. The products are presented in sequence as applying to each of these industries and there are many charts and tables covering the physical and chemical properties, together with application and operational data on these products. Copies may be obtained from the company, 30 E. 42nd Street, New York (17), New York.

▲ Described in a new bulletin is a new Junior Phil-Dump car which has been added to the line of Phil-Dump haulage equipment by Phillips Mine and Mill Supply Company. A hand push model, the Junior Phil-Dump has a one-half cubic yard capacity, and is available with solid rubber tires only. The overall dimensions of the car are 66 inches long, 38¼ inches high and 24¼ inches wide.

Copies of the bulletin may be secured by writing this publication, or direct to Phillips Mine and Mill Supply Company, 2217 Jane Street, Pittsburgh 3, Pennsylvania.

▲ A new 12 page, four-color bulletin, No. ADG-2008, describing the Airco 45 and 45M high speed machine gas cutting tips which control the expansion of cutting oxygen, has been published by Air Reduction.

Cross-sectional drawings and photographs clearly show how the especially designed orifices in these tips release a high velocity stream of oxygen to cut a narrower path or kerf than the standard cutting tips. Photographs show how the newer 45M tip is designed for heavier preheat making it particularly adaptable for cutting rusty and scaly plate, bevel cutting, and cutting with hydrogen as a fuel gas.

Other illustrations, including charts and tables, give valuable specifications data for both the 45 and 45M tips. Copies of bulletin ADG-2008 are available on request from Air Reduction Sales Company, 60 East 42nd Street. New York 17, New York, or any local Airco office.

A. I. S. E. DISTRICT SECTION MEETINGS

BIRMINGHAM — Monday, March 26, 1945

"Elementary Discussion of Tool Steels," by C. H. Vaughn, District Manager, Allegheny-Ludlum Steel Corporation, Birmingham, Alabama.

BUFFALO — Tuesday, March 13, 1945

"Induction Heating — At War Today — At Peace Tomorrow," by Dr. H. B. Osborn, Jr., The Ohio Crankshaft Company, Cleveland, Ohio.

CLEVELAND — Monday, March 19, 1945
YOUNGSTOWN — Tuesday, March 20, 1945

"Modern Distribution Systems for Steel Mills," by H. W. Poole, Application Engineer, General Electric Company, Schenectady, New York.

PHILADELPHIA — Saturday, March 3, 1945

"Modern Electric Weld Tube Mills," by John Lucas, President, The Yoder Company, Cleveland, Ohio.

PITTSBURGH — Monday, March 12, 1945

"The Application of Electrolytic Tin Plate," by Dr. K. W. Brighton, Research Division, American Can Company, Maywood, Illinois.

"Factors in the Production of Electrolytic Tin Plate," by A. H. Brisse, Development Metallurgist, Sheet and Tin Division, Carnegie-Illinois Steel Corporation, Gary, Indiana.

DETROIT — Tuesday, March 13, 1945

"Effect of the Charge on Operating Conditions in the Basic Open Hearth." by H. F. Lesso, Control Metallurgist, Great Lakes Steel Corporation, Ecorse, Michigan.

LINCOLN

CENTRO-MATIC LUBRICATING SYSTEMS

Are Easy to Install

ONLY ONE SINGLE LUBRICATION LINE IS NECESSARY

No return lines are necessary on the Lincoln Centro-Matic Lubricating System. All that is required is one Centro-Matic Injector for each bearing, each adjusted to deliver the exact amount of lubricant required. The injectors can be arranged singly, or in manifold and connected by only a single line to a Centro-Matic Lubricant Pump. The pump can be either manually-operated or power-operated. Power-operated systems can be time-clock or push-button controlled. One Centro-Matic System can be applied to a single machine or to a battery of machines and all bearings can be lubricated while machines are in operation. *An example of what can be accomplished—a Lincoln Centro-Matic System now in use is lubricating 1000 bearings in 5 minutes. This system consists of 1000 injectors, one for each bearing, 3000 feet of pipe and tubing; and lubricant is dispensed from a single Centro-Matic Pump.*

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ARMY E NAVY

LINCOLN ENGINEERING COMPANY

Pioneer Builders of Engineered Lubricating Equipment

5701 NATURAL BRIDGE AVE., ST. LOUIS 20, MO., U. S. A.

▲ General Electric Company announces three new bulletins: GEA-4140 — Vibration-Measuring Equipment. This bulletin describes three instruments for measuring vibration, giving their range, accuracy, applications and use.

GEA-4246 — Electric Equipment for Arc Furnaces. Described here are the furnace transformers, switchgear and electrode control manufactured by the company.

GEA-4317 — High-voltage D-c Supply. This folder describes a unit type metal-enclosed d-c supply which can be designed for d-c voltages up to about 50,000. These units form a convenient source of high-voltage d-c power for testing electric equipment, precipitation, induction heating, radio and miscellaneous industrial and electronic applications.

▲ A folder just issued by the Youngstown Welding and Engineering Company, Youngstown, Ohio, describes a new steam jet for use in pickling tanks. The jet can be hooked on to existing piping without any special arrangement. Steam issuing from the nozzle through a bell-shaped throat made of corrosion-resistant Monel metal sets up a rapid circulating action in the bath, insuring rapid pickling. Copies of this bulletin may be had upon request.

▲ An unusually complete V-belt drive catalog, with all of the required information to make correct drive selections reduced to handy charts, tables and drawings, has just been released by the Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin.

Newest V-belt drive product covered in this Texrope drive engineering summary is the company's new "Magic-Grip" sheave, designed for fast, easy mounting and dismounting. A quick-picture story of the sheave and complete facts for applying are offered.

Another section covers the Texrope "Econograph" method of drive selections, now widely used where drive designing is frequently necessary. The new catalog, B6051E, may be obtained from the Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin.

▲ The Ingersoll-Rand Company announces the publication of a new 24 page, two-color booklet entitled, "A Little Air Power Will Do Many a Big Job."

Mainly photographic in format with a minimum of text it is designed to be a useful addition to every shop man. It is a book that will be opened frequently for its "easy to get" ideas in the many illustrations. In fact, it is a virtual clearing house to enable production men to benefit from one another's ideas and to show what is being done with small compressors or with a small amount of air from a shop air line.

Copies of the booklet, catalog 1011, may be obtained by writing or phoning the company at 11 Broadway, New York 4, New York, or any of its service branches throughout the country.

▲ A new bulletin, No. 902, describing the Peabody type M gas burner and the combined gas and oil burner has been published by the Peabody Engineering Corporation, of 580 Fifth Avenue, New York 19. It describes and illustrates the mechanical and operating features of these burners, for natural or forced draft operation.

CONDULETS

are made only by CROUSE-HINDS

The Crouse-Hinds Company introduced the first cast electrical conduit fitting that was ever manufactured. Identified by the Crouse-Hinds trade name, **CONDULET,** this fitting was so well designed that it quickly revolutionized electrical conduit installation practice. Today, the complete CONDULET line, greatly expanded and improved, is still the Standard of Quality in the field of electrical conduit fittings.

The WEDGENUT fastener, an exclusive Crouse-Hinds feature, is part of the cover. Screws can't fall out. No screw holes to locate. When tightened by the WEDGENUT fastener, the cover automatically seats itself, firmly contacting entire surface of cover opening.

The Obround CONDULET was the original cast electrical conduit fitting. Today's improved CONDULETS have quality features not found in any other conduit fitting.

Taper Tapped Threads, an important Crouse-Hinds feature. The threads on tapered conduit bear against every thread in the hub of a taper tapped CONDULET. This provides the most rigid joint, not affected by vibration. Assures permanent ground continuity.

CONDULETS are made only by Crouse-Hinds and every genuine CONDULET bears the Crouse-Hinds trade name, **CONDULET,** or the Crouse-Hinds trade-mark

When a gasket is used, you have a thoroughly **Weatherproof** enclosure.

Obround CONDULETS are a large and useful Series in the big CONDULET family. There are **49** different Obround Types listed in CONDULET Catalog No. 2500, Section 5. Sizes to fit ½" to 6" conduit. Three styles of hubs: for thick wall threaded conduit; for thick wall threadless conduit; for thin wall threadless conduit (electrical metallic tubing). In addition to plain covers, a variety of wire hole, switch, and receptacle covers are available.

A Nationwide Distribution Through Electrical Wholesalers

CROUSE-HINDS COMPANY
SYRACUSE 1, N. Y., U.S.A.

Offices: Birmingham — Boston — Chicago — Cincinnati — Cleveland — Dallas — Denver — Detroit — Houston — Indianapolis — Kansas City Los Angeles — Milwaukee — Minneapolis — New York — Philadelphia — Pittsburgh — San Francisco — Seattle — St. Louis — Washington
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CONDULETS · TRAFFIC SIGNALS · AIRPORT LIGHTING · FLOODLIGHTS

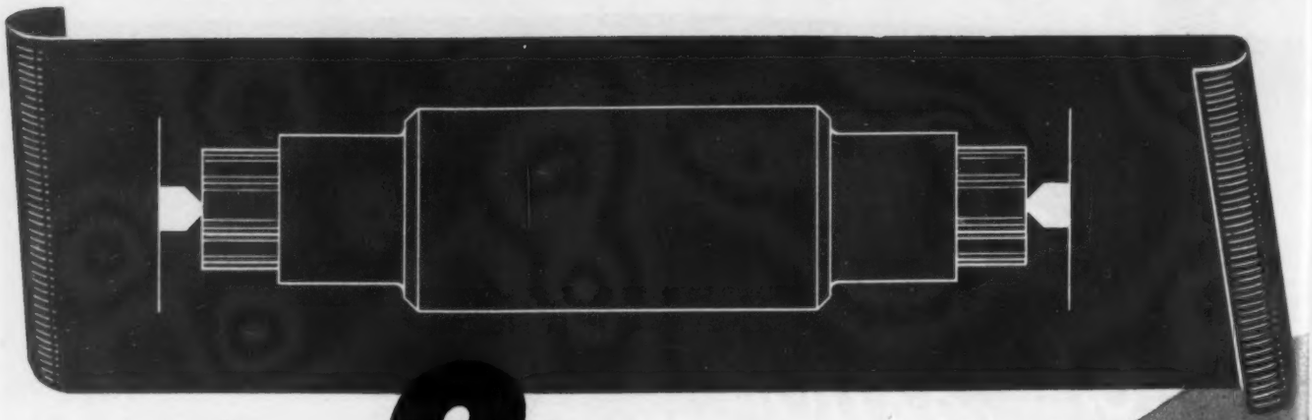
Casters in this bed made by Service Caster & Truck Division of Domestic Industries, Inc. Albion, Michigan

Easier rolling of plates and less frequent lubrication on a caster-bed application, in a large Chicago steel plant, was obtained using Hyatt Roller Bearing equipped casters.

This is one of many instances where Hyatt Roller Bearings have speeded up and simplified steel mill operation. Other applications are in tables, cranes, cars and mill motors. Let us help solve your bearing applications.

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION

HARRISON, NEW JERSEY • CHICAGO • DETROIT • PITTSBURGH • OAKLAND, CALIFORNIA



HOW 2 DEAD CENTERS IMPROVE ACCURACY OF GRINDING

In grinding roll necks, shafts or similar work in machines having live centers, the degree of accuracy possible to attain in the work is limited in advance by the accuracy of the center spindle bearings. Any attempt to hold to close limits only results in excessive grinding time without producing the desired results.

This cause of inaccuracy is eliminated in Farrel grinding machines by having dead centers in both the headstock and footstock. A positive setting of the work is provided, and there are no variations as the work revolves.

The drive is self-equalizing, and of extremely simple design. It consists of a faceplate attached to the main drive pulley, a driving bar swiveled in the faceplate, and two driving dogs mounted in "T" slots in the driving bar.

The driving dogs are steel rollers, rubber cored and brass bushed, and mounted on T-head studs which fit in the slots of the driving bar. They drive the work by engaging either the roll wabbler or a clamp bolted to the end of the work.

This is only one of the many features of Farrel Grinders which contribute to their reputation for extreme accuracy and high rate of production. For the full story, write for descriptive bulletins. No cost, no obligation.

FARREL-BIRMINGHAM COMPANY, INC. • ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
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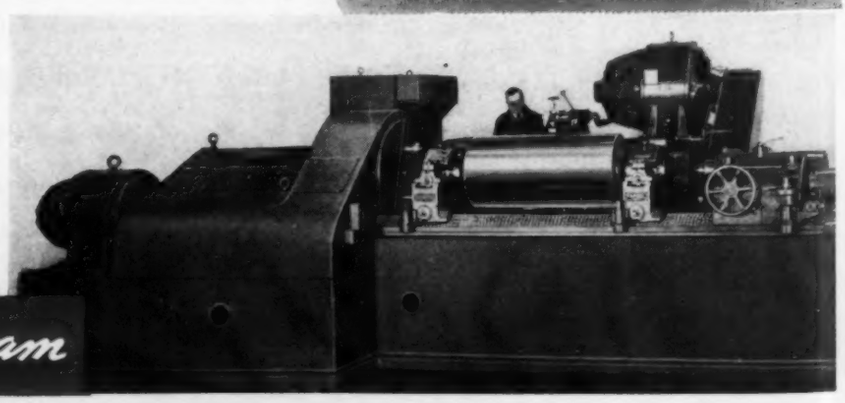
- Rolls
- Rolling Mills
- Rod Mill Tables and Manipulating Equipment
- Universal Mill Spindles
- Rod Coilers
- Gears
- Gear Drives of any Capacity
- Mill Pinions
- Pinion Stands
- Flexible Couplings
- Roll Grinding Machines
- Roll Calipers
- Lead Presses for Pipe or Rod



Farrel-Birmingham

Personnel News

Walter C. Titus, who has been associated with Allegheny-Ludlum Steel Corporation for the past twenty years in various capacities, most recently as director of safety and assistant personnel director, is retiring. **Harry L. Myers,** for many years manager of the West Leechburg plant, has been appointed assistant personnel director of the corporation with headquarters at Brackenridge, succeeding Mr. Titus. **George C. Floyd,** who has been assistant plant manager at West Leechburg since 1936, has been appointed plant manager.

Everett C. Hite, has been appointed combustion and refractories engineer in the steel mill metallurgical department of The Timken Roller Bearing Company, Canton, Ohio. Mr. Hite, who has been an assistant engineer in the same department, was educated at Pleasantville (Ohio) high school and Ohio State University, where he earned the degree of bachelor of ceramic engineering in 1935, then going to The Timken Company.

John J. Yezbak has been appointed manager of public relations as well as the news bureau of The Timken Roller Bearing Company, Canton, Ohio. Mr. Yezbak, who has been head of the firm's news bureau since joining the company in June, 1943, is a graduate of New York University.

A former Pennsylvanian, Yezbak has been editor of The Barnesboro (Pennsylvania) Star, an advertising agency account executive with Belden Associates in Cleveland; and for several years prior to his association with Timken, operated his own advertising agency in Cleveland.

The newly-created public relations department was organized to co-ordinate all public relations activities of the company.

N. R. Johnson has been named factory manager for the Buffalo Forge Company, Buffalo, New York. Mr. Johnson has been connected with the company for 28 years and for a number of years has been general purchasing agent. His outside contacts, as well as a thorough knowledge of the company's products and manufacturing problems fit him particularly well for the new post.

H. D. Hebard was, at the same time, made director of purchases for Buffalo Forge Company. Mr. Hebard has been with the company for 24 years, most of this time in sales work. For the past three years he has been assistant to Mr. Johnson in the purchasing department.

George A. Fort has been appointed plant industrial engineer of the Gary works, Carnegie-Illinois Steel Corporation, and **Milton L. Weislogel** has been made an assistant plant industrial engineer.

Mr. Fort had been assistant plant industrial engineer of Gary works since March 1943. He was first employed at Carnegie-Illinois in 1936 on the staff of the chief industrial engineer in the Pittsburgh office and later advanced to assistant industrial engineer, Youngstown district, prior to his transfer to Gary.

Mr. Weislogel began his service with Carnegie-Illinois in June 1936 and progressed through various positions until October, 1941, when he was appointed assistant to division superintendent, coke works and blast furnaces, industrial engineering, the position he held until his present appointment.

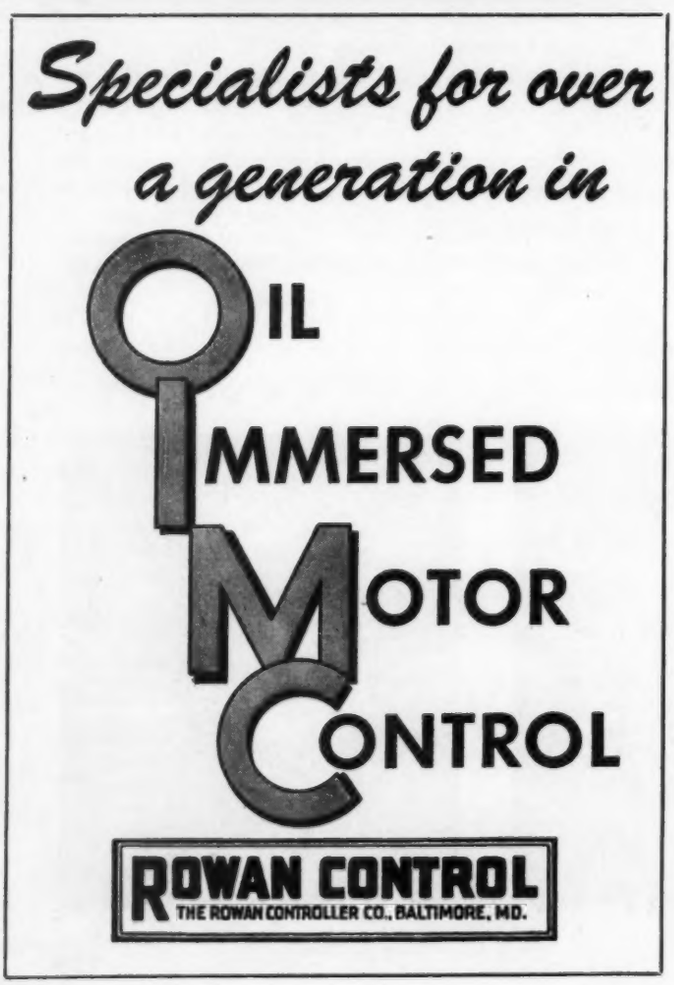
C. O. Kleinsmith has been elected a vice president of National Carbon Company, Inc., a unit of Union Carbide and Carbon Corporation. Mr. Kleinsmith was formerly general sales manager for the company's "Eveready" products. Prior to his appointment to that position, two years ago, he was sales manager for eastern United States. He joined the company in 1919.

D. B. Joy has been appointed general sales manager for carbon products for National Carbon Company.

G. C. FLOYD

C. O. KLEINSMITH

D. B. JOY



Mr. Joy joined the company in 1923 after graduating from Massachusetts Institute of Technology. He was made director of the company's process engineering laboratory at Fostoria, Ohio, ten years ago, and in 1941 became assistant superintendent of the Fostoria factory. He was made product manager last year.

Lester E. Lighton, manager of the development and design department of The Electric Storage Battery Company, Philadelphia, was recently elected vice-president in charge of engineering. Mr. Lighton brings to his new position a quarter century of experience in battery engineering and sales. His career with Exide started in 1920 on the sales staff of the company's Detroit branch. Later, in 1925, he was promoted to manager of automotive manufacturers sales, with headquarters in Philadelphia. In 1935 he was assigned to the department of development and design as assistant to the manager, and in 1940 became manager of that department.

Willard M. Robinson, formerly open hearth superintendent of Wickwire Spencer Steel Company, Buffalo, New York, has joined the sales organization of the Joseph Dixon Crucible Company, Jersey City, New Jersey as field representative in the Pittsburgh and Valley districts.

Glen McDowell was recently appointed assistant to the vice-president of the Aetna-Standard Engineering Company, Youngstown, Ohio. Mr. McDowell has been employed by Aetna-Standard since 1925, working in the engineering and estimating departments until 1933, and since that time has been in their roll sales department.

C. C. BRAY

Charles C. Bray has been appointed assistant to the manager of the worm gear division of the De Laval Steam Turbine Company. Prior to accepting this position, he served as a metallurgist for the special steel department of the Philadelphia office of Joseph T. Ryerson and Sons. Mr. Bray is not a newcomer to the De Laval organization, having served for ten years as a worm gear sales engineer in the Chicago office before leaving to join the Ryerson organization.

John Lucas, formerly vice-president and assistant general manager of The Yoder Company, Cleveland, Ohio, was elected president and general manager of the company, succeeding **Carl M. Yoder,** one of the founders of the company, who died last month. **Harvey O. Yoder,** also one of the founders, remains as secretary-treasurer of the company. **Frank Sargeant,** formerly assistant treasurer was elected assistant secretary and assistant treasurer. Mr. Lucas joined the Yoder Company in 1935 as general sales manager, having previously been with the Lewis Foundry and Machine Company of Pittsburgh. Previous to that he accumulated many years of experience as sales and productive executive with machinery building companies.

JOHN LUCAS

James H. Baldrey has been appointed superintendent of the melting department, Allegheny-Ludlum Steel Corporation, Watervliet, New York, succeeding **T. F. McClester,** who is retiring after twenty years in this position. **Edward J. Doyle** has been appointed superintendent of the hammer shop, replacing **W. H. White,** retiring after twenty-five years service in this position.

Kenneth W. Huffine was elected vice-president of the Johns-Manville Products Corporation.

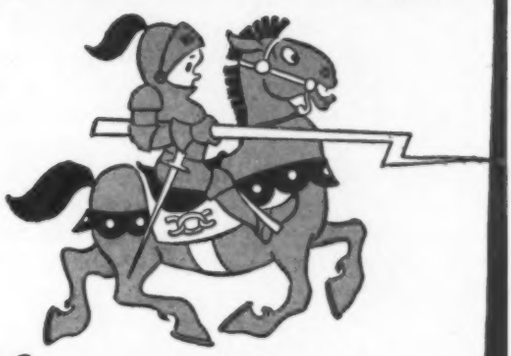
Formerly manager of the Johns-Manville plant at Waukegan, Illinois, Mr. Huffine in his new capacity will be in charge of a new department at New York headquarters created to consolidate engineering activities in the mining and manufacturing division to meet the production demands of wartime operations, and to expand plant engineering programs in preparation for post-war production plans of the company.

James C. Hartley has been appointed director of research of the Heppenstall companies, Pittsburgh, Bridgeport, and Detroit. The research laboratories are located at Heppenstall Company's plant in Pittsburgh. Mr. Hartley has also been appointed chairman of the Heppenstall research committee.

Prior to coming with Heppenstall, Mr. Hartley was chief metallurgist for Aluminum Forgings, Inc., Erie, Pennsylvania, where he directed the production of aluminum forgings and conducted research on the forging of magnesium.

What do you know!

A GI JOE OF LONG AGO!



Ancient in dress, modern in purpose-

The MORGAN KNIGHT

comes to serve you!

His adventures—amusing and interesting—make good reading. With a few appropriate words and pictures, MORGANITE is proud to revive these legends of the past. Each will be augmented with data and information of particular interest to engineers and designers. Watch for the MORGAN KNIGHT on these pages in subsequent issues. Morganite Brush Co., Inc., Long Island City 1, New York.

Morganite

CARBON BRUSHES

Orville R. Lyons has been appointed as preparation engineer in the northern coal mines of Republic Steel Corporation was announced today by J. L. Hamilton, manager of Republic's northern coal mines.

Mr. Lyons is a graduate of the University of North Dakota in mining engineering and geology and received a master's degree in mining engineering at the University of Alabama in 1940. He came to Republic from the Battelle Memorial Institute, Columbus, Ohio, and will make his residence in Clarksville, Pennsylvania.

Kendall A. Redfield, assistant general sales manager and advertising manager of Rockbestos Products Corporation, New Haven, Connecticut, resigned to become president and general manager of Associated Seed Growers export division. **Edward M. Heery,** assistant advertising manager, advanced to advertising manager. At the same time **Robert B. Lattin,** former factory manager, assumed the newly-created post of technical director and **Stephen S. Nichols,** former assistant factory manager, advanced to factory superintendent.

Leonard S. Poffinbarger has been named field representative for the Trumbull Electric Manufacturing Company in the Chicago district. Mr. Poffinbarger has had a lot of experience in the electriacl field as a city electrical inspector and as a construction and designing engineer.

Arden LeFevre, has been appointed a vice-president and director of engineering for Stewart-Warner Corporation in charge of Alemite, instruments and radio, filling the vacancy left by the recent death of **Frank Johnston.** Mr. LeFevre joined Stewart-Warner in 1925 as a designer. In his nearly 20 years with the company he has been secretary of the engineering department, assistant chief engineer, chief engineer for the alemite, automotive instrument, and accessory divisions, Indianapolis plant manager, and sales manager of standardized sales. In research and development work he has made notable contributions.

George W. Oehlsen, Jr., named assistant director of engineering, joined Stewart-Warner Corporation in 1925 as a designer, shortly after leaving school. His work has been devoted chiefly to radio development. He has served as assistant chief engineer of the radio division for a number of years. In his new capacity he will act as executive assistant to LeFevre, supervising engineering staffs.

Fred R. Cross has been made advertising manager of Stewart-Warner Corporation. Mr. Cross started in the advertising department of Bassick Manufacturing Company (now a Stewart-Warner subsidiary). In 1925 he was appointed Alemite advertising manager. In 1933, when Bassick merged with Stewart-Warner, Cross was appointed general advertising manager of the parent

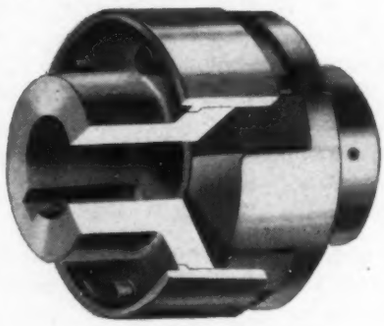
L-R FLEXIBLE COUPLINGS

***EXCEL** in all Steel Mill services*

"Resilient Alignment" L-R Couplings are particularly designed for the accuracy, responsiveness, durability and dependability required for correction of misalignment, take-up of shock and vibration in steel mills. Resilient free-floating load cushions (various materials fitted to service) suspended between rugged jaws adjust instantly to every emergency. Cushions always in sight for inspection. No lubrication required. NO SHUT-DOWNS FOR CHANGING. New standard of quiet performance.

Wire or write for Complete Catalog, with Quick-Finding Selector Charts.

Should be in every engineer's file. Couplings to 2500 hp. Special couplings engineered.



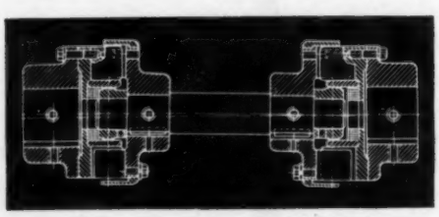
LR Type H

Heavy Duty. Electric steel castings or steel forgings. Greater number of jaws. 4.60 to 806 hp. at 100 r.p.m. Bores 1½ to 9½". Pat. and Pats. Pend.

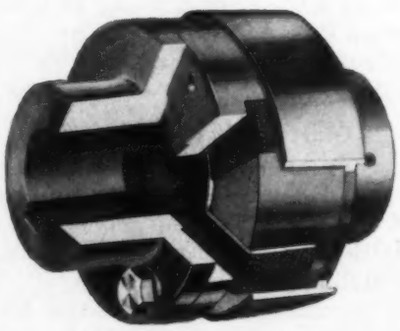
Operating Assembly

LR TYPE HKQ

Flexible Floating Shaft Coupling



Applicable to either horizontal or vertical drives. Eliminates whipping of shaft ends at any speed. Quick disassembly without disturbance. Prevents chattering. Either coupling body may be used on a V-belt sheave. Bores 1½" to 8½". 7, to 800 h.p. at 100 r.p.m. For various distances. Pat. and Pats. Pend.



LR Type HQ

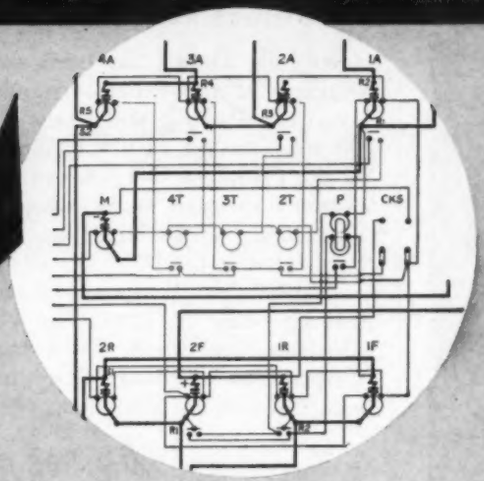
Heavy Duty. Either half can be independently rotated for timing engines. 3.91 to 744 hp. at 100 r.p.m. Pats. and Pat. Pend.

LOVEJOY FLEXIBLE COUPLING CO.

5016 W. LAKE ST. CHICAGO 44, ILL.

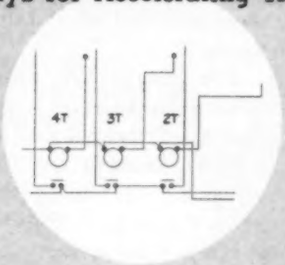
It's as SIMPLE AS THIS!

THIS



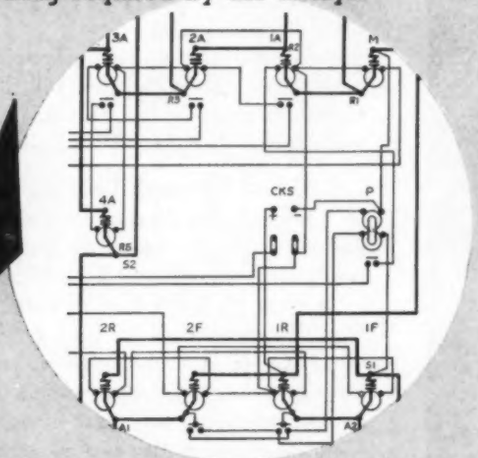
You recognize this drawing as a conventional D.C. Reversing Plugging Mill Controller Wiring Diagram, using separate Relays for Accelerating Timing.

MINUS THIS

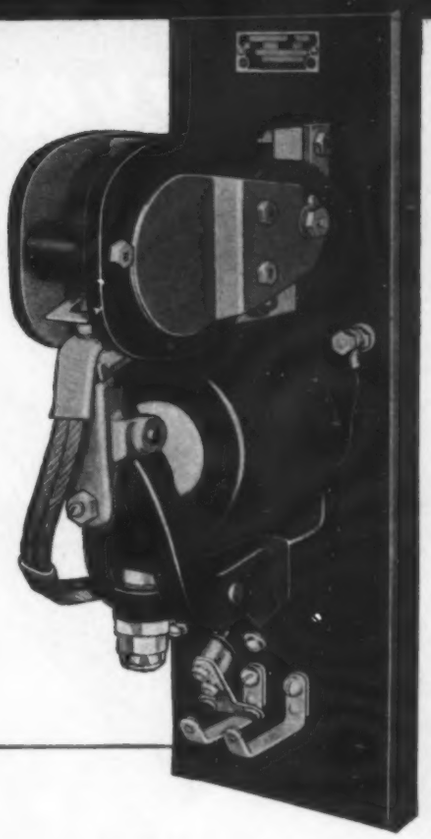


The Operating Coils, Electrical Interlocks, and the Wiring required by the Relays.

EQUALS THIS



A D.C. Reversing Plugging Mill Controller Wiring Diagram using Clark Bulletin 7400 Vari-Time Contactors, thus giving you an adjustable definite time Acceleration, and still eliminating the need for Accelerating Relay Coils, Interlocks, and Wiring.



Bulletin 7400
Type RT Vari-Time Contactor

The "3C" Bulletin 7400 Vari-Time Contactor gives you adjustable, definite Time Acceleration without Accelerating Relay Coils, Interlocks, and Excess Wiring.

The Vari-Time Element never needs maintenance nor repairs. There are no separate Time Relays to maintain. There is less Panel Wiring. Fewer of all repair parts are needed, because wearing parts for Main and Accelerating Contactors are duplicates.

Ask for fully descriptive Bulletin 7400.

THE CLARK CONTROLLER CO.

1146 EAST 152nd ST., CLEVELAND 10, OHIO • CONTINUE TO ROLL WITH CLARK CONTROL

company, holding this position until 1939 when he was made Alemite retail sales manager. Early in 1943, Cross joined Aro Equipment Corporation. It is from this connection that he rejoins Stewart-Warner Corporation, as advertising manager.

Roy P. Tooke has been appointed assistant chief engineer of the general engineering division of The American Rolling Mill Company. Mr. Tooke first became associated with the Armco organization in 1924 as a draftsman at the Ashland, Kentucky plant. In 1931 he was appointed works engineer of that plant and was later made works engineer of the company's Butler, Pennsylvania plant.

In 1942, Mr. Tooke was placed in charge of the engineering work in connection with construction of the Mexican steel plant which the Armco International Corporation was constructing in association with Mexican interests at Monclova, Mexico.

Obituaries

C. W. Heppenstall, chairman of the board of Heppenstall Company and a long-time leader in the nation's steel industry, died January 15 in Pittsburgh, Pennsylvania.

For nearly fifty-two years, Mr. Heppenstall was associated with the company which bears his name, and was chiefly responsible for its growth. Starting with the concern as office boy, and later a worker in the plant, he had been since 1898 successively superintendent, general manager, president and board chairman.

Known for many years as an eminent figure in the steel forgings industry, Mr. Heppenstall was widely credited with successful pioneering in the development of equipment and processes now generally adopted within this industry.

Born in Philadelphia on June 12, 1872, the son of Sam and Alice Talbot Heppenstall, he was a member of the fourth successive generation of his family in the iron and steel industries of England and the United States.

Charles Edward Brown, executive vice president of The Okonite Company died in Chicago, Illinois on January 13. He was well known throughout the railroad, electric utility, industrial and wholesaling fields.

Born in Philadelphia, Pennsylvania, on July 15, 1866, Mr. Brown started his long business career in Chicago, with Marshall, Field and Company in 1884. Five years later he became associated with the McKinlock Brothers as vice president and part owner of the Central Electric Company, one of the earliest and largest of the electrical wholesale organizations in the United States. His experience there as a distributor of Okonite wires, cables and tapes led to his joining The Okonite Company in 1925 as executive vice president in charge of all sales through the middle west. He had been an Okonite director since 1919 and continued in this capacity until his death. During the same period, he was also a vice-president and director of The Okonite-Callender Cable Company, Inc.

In 1943, at their annual meeting the National Electrical Manufacturers Association presented Mr. Brown with a citation and fifty-year certificate because of his long and untiring service as a pioneer in the electrical industry.

REMEMBER ROCKBESTOS A.V.C.

For Those Hot-Spot Installations You'd Like to Forget

ROCKBESTOS A.V.C. 600 VOLT POWER CABLE
(National Electrical Code, Type AVA)

This cable and Rockbestos A.V.C. Motor Lead Cable have a maximum operating temperature rating of 110° C. (230° F.) and this permanently insulated construction:

1. A tough rugged asbestos braid, resistant to heat, flame, moisture, oil, grease or corrosive fumes.

2. Outer felted asbestos wall, impregnated with heat, flame, and moisture resistant compounds, serves as an effectiv barrier against high ambient temperatures and flame.

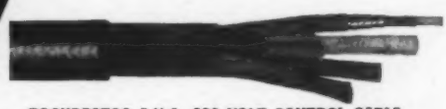
3. Lubricated varnished cambric for high dielectric strength and added moisture resistance, protected from heat and flame by two felted asbestos walls.

4. Felted asbestos insulation, also impregnated with heat, flame and moisture resisting compounds, withstands conductor-heating overloads and won't dry out, bake brittle, flow or burn.

5. The conductor is perfectly and permanently centered in helically applied insulation.

One of 122 different wires and cables developed for severe operating conditions by Rockbestos.

WON'T bake brittle, bloom, burn or rot.
RESISTS moisture, oil, grease and fumes.



ROCKBESTOS A.V.C. 600 VOLT CONTROL CABLE

In one to 19 conductors. Standard stranding AWG No. 12—19/No. 25 and No. 9—19/No. 22. Other sizes and strandings furnished.

Designed for use under conditions too severe for control cables with other types of insulation which deteriorate rapidly when exposed to high temperatures. Operates without failure under the attack of heat, oil, grease or corrosive fumes and may be installed in conduit as it has ample moisture resistance.

THERMOSTAT CONTROL WIRE—TABLE TC

Sizes No. 14, 16 and 18 AWG in two to six conductors with 12½, 25 or 31 mil wall of felted asbestos insulation and cadmium plated steel armor.

A multi-conductor control wire for low voltage intercommunicating, signal and temperature control systems. Its life time insulation and rugged steel armor will give you troubleproof circuits.

The way to wipe out wire-worries is to install Rockbestos A.V.C. in all those hot-spots that are likely to cause trouble . . . soaking pits, forging presses, steam tunnels, lehrs, kilns, furnaces, boiler rooms, etc. With Rockbestos A.V.C. circuits you can depend on trouble-free service year after year, thus saving the time and money required by frequent rewiring jobs.

Rockbestos A.V.C. has a *permanent impregnated asbestos insulation* which stands up in operating temperatures up to 230° F. without baking or cracking. It resists heat, flame, oil, grease, moisture and corrosive fumes . . . won't bloom, flow, swell or rot under exposure to severe heat and vibration.

Rockbestos A.V.C. is available in many standard constructions for service requirements ranging from 600 to 5000 volts. When ordering or inquiring, please furnish CMP allotment symbol and certification. For complete information and samples, write nearest branch office or:

Rockbestos Products Corporation, 977 Nicoll Street
New Haven 4, Connecticut

ROCKBESTOS A.V.C.

The Wire with Permanent Insulation

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GOOD BEARINGS

ARE BASIC IN GOOD DESIGN

You won't get far in postwar competition without good bearings. And for any machine, a good bearing means simply that type which handles the load most efficiently and economically with the least maintenance cost and worry. That's where Rollway's Right-Angle Loading shines. It reduces load magnitudes and simplifies stresses. There's no piling of thrust loads on radial bearings or radial loads on thrust bearings. Shut-downs for bearing service and replacement are few and far between.

No Oblique Resultants . . .

Rollway's Right-Angle Loading splits compound loads into their two components of pure radial and pure thrust. Each component is carried at right angles to the roller axis on separate bearing assemblies. No oblique loads and resultants, no thermal float or uncalculated thrust can impose secondary pressures on any Rollway Bearing. That means a bearing of given dimension will last longer, or carry heavier loads, or run at higher shaft speeds, or give any proportional combination of all three. Send us your drawings for free analysis. Without cost or obligation, we'll tell you how to get more service from your bearing dollars.

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Which drive?

- ELECTRIC
- STEAM
- OIL
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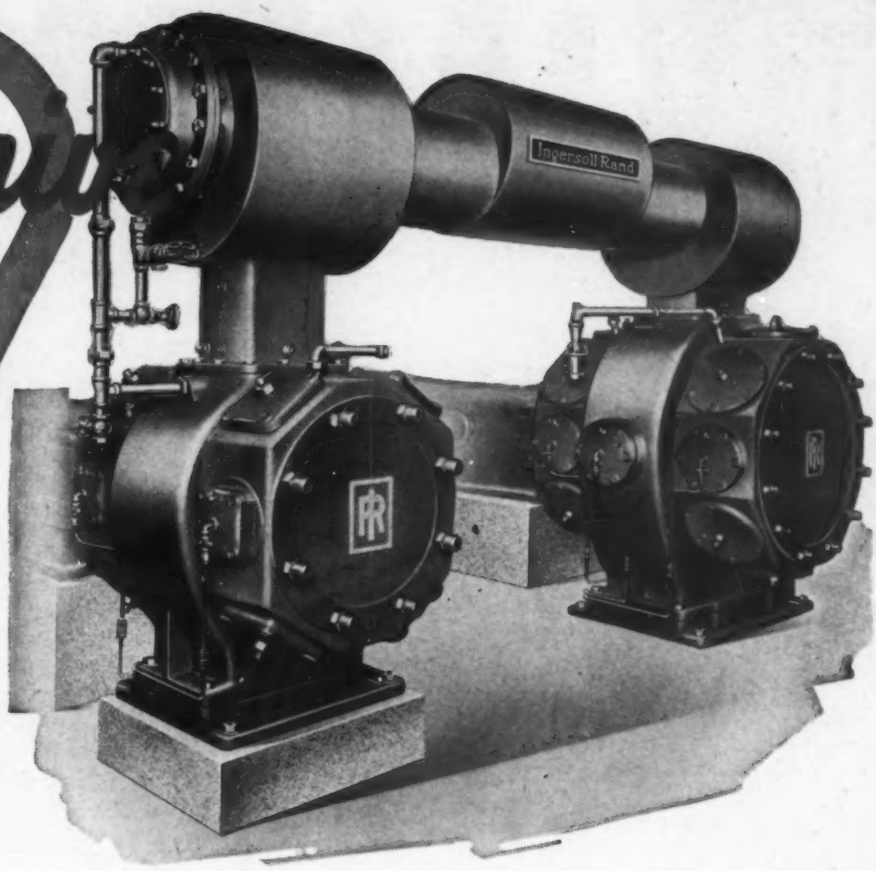

THERE'S ALWAYS ONE BEST DRIVE FOR YOUR COMPRESSOR

Perhaps it's a direct-connected electric-motor which best fits in your over-all power layout . . . a synchronous motor improves the power factor.

Or it may be steam, especially when the exhaust can be profitably used in process work or heating.

Then there are conditions best met by direct-connected oil- or gas-engine drive. In other cases, belt drive may be the correct solution.

But there is always *one best* choice, and there is no need to guess the answer. Ingersoll-Rand can furnish you compressors with any type of drive, and I-R engineers will be glad to study the problem with you, helping you select the compressor which best suits *your* conditions.

Ingersoll-Rand

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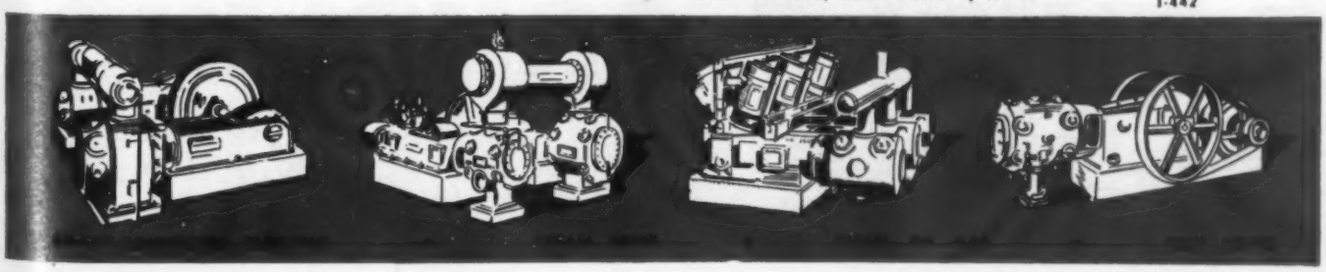
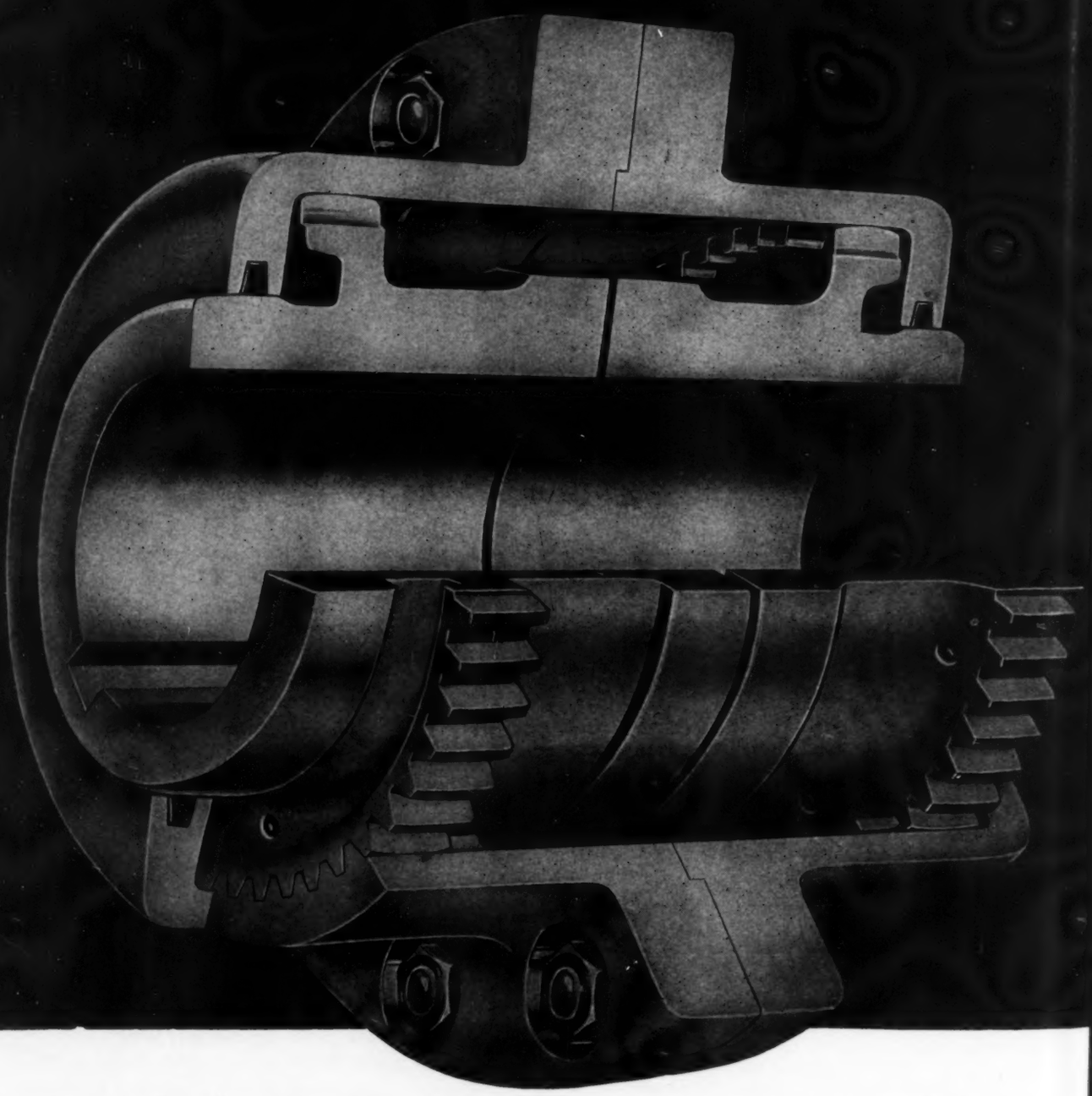


POOLE

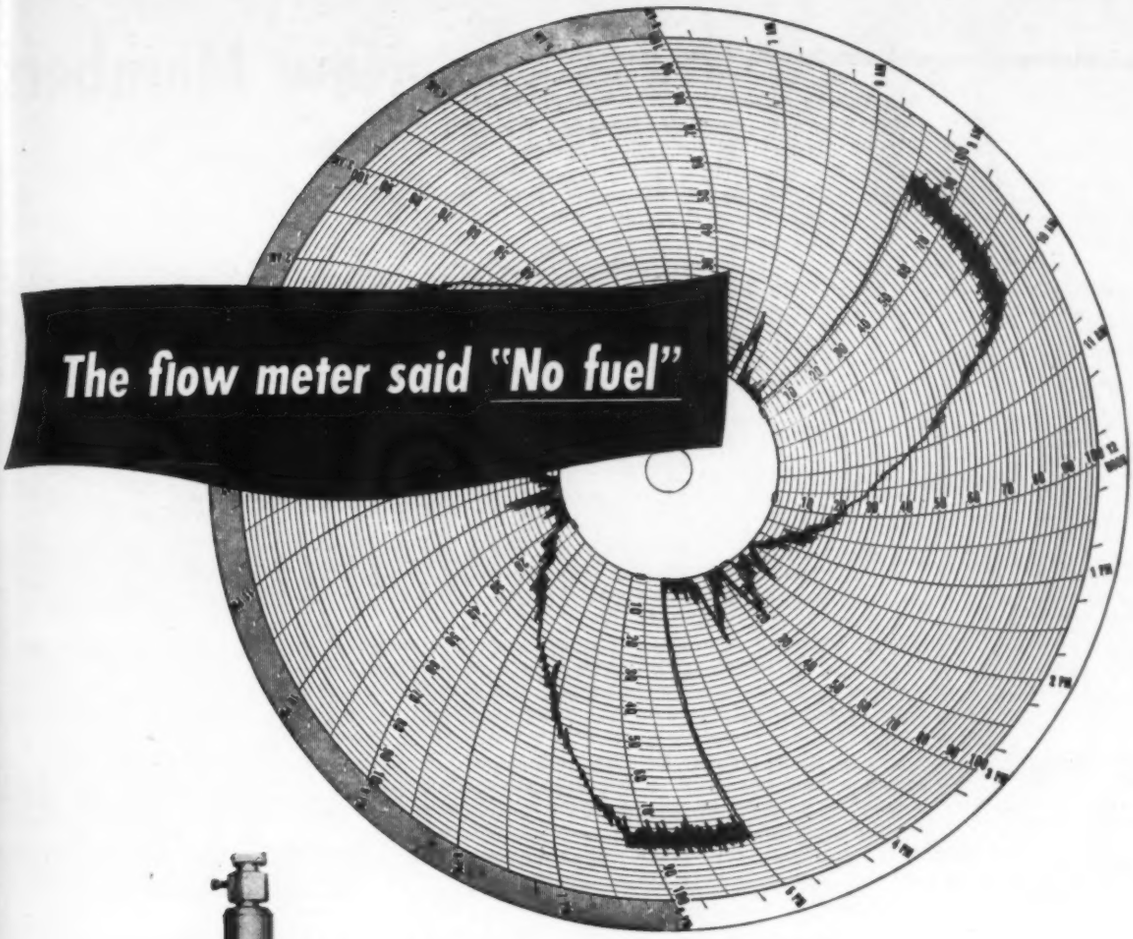


A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST

FLEXIBLE COUPLINGS

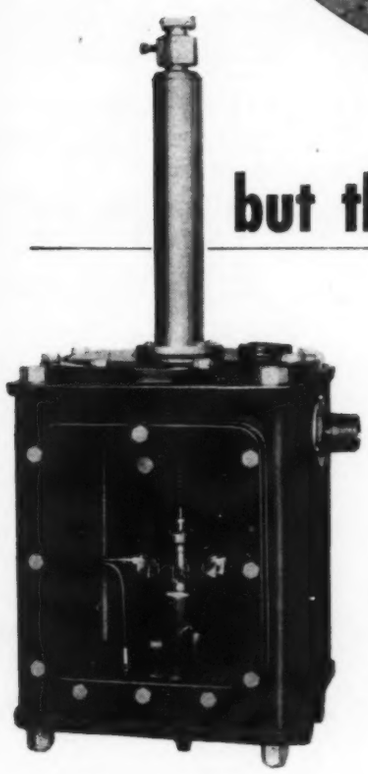
POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.



The flow meter said "No fuel"

but the Hagan Control knew better



HAGAN Spinning Pilot Valve—an exclusive development that gives Hagan Control its high sensitivity and fast response.

It happens right along in a Pennsylvania steel plant, where Hagan Automatic Combustion Control is used on soaking pits.

Large amounts of fuel are needed to bring the cold ingots up to temperature. After they have been heated a very small percentage of the maximum amount holds the pit temperature at the correct level. When fuel demand drops down around 8%, the flow meter registers zero—but hour in and hour out Hagan Control continues to supply the right amount of fuel to maintain the right temperature.

Only one thing makes this possible—the high sensitivity and accuracy of the Hagan Control System.

HAGAN CORPORATION · HAGAN BUILDING · PITTSBURGH 30, PA.

HAGAN HALL BUROMIN CALGON

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The pioneer . . . and still the leader

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SAND!!

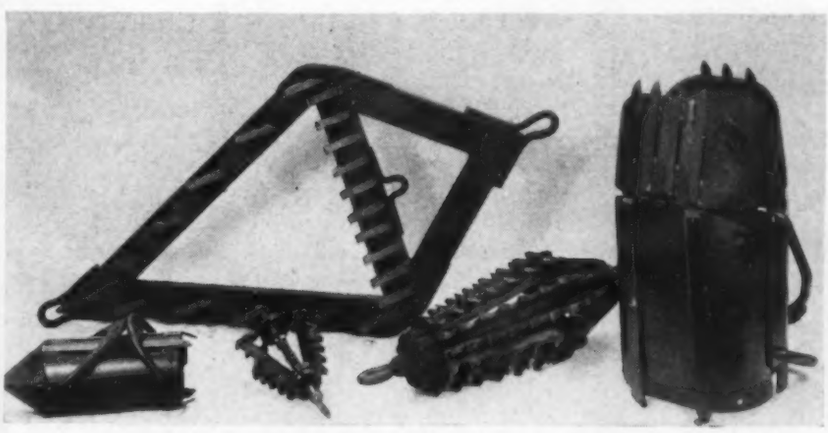
Valuable material—Sand. On the hard pull or the quick stop there's nothing better for the job.

BUT

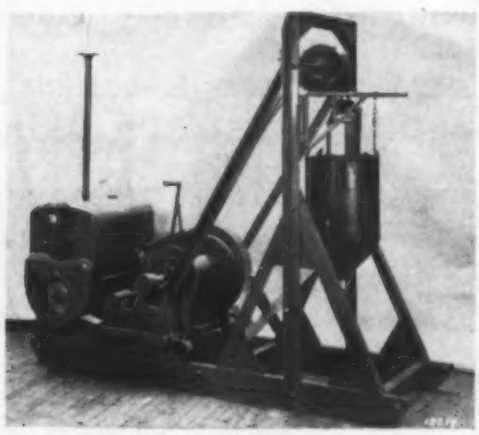
When sand and mill scale get in sewers, it's just bad news. The pile of scale and dirt at left was taken from only 75′ of 36″ sewer.

LET PITTSBURGH PIPE CLEANER COMPANY CLEAN YOUR SEWERS!

Why waste precious hours doing a job that requires a specialist with special tools?



Buckets for removing dirt, and slitters for breaking up hard scale.



Gasoline powered winches guarantee a steady, fast pull in removing dirt.

PITTSBURGH PIPE CLEANER COMPANY

433 Melwood Street **Pittsburgh 13, Penna.**

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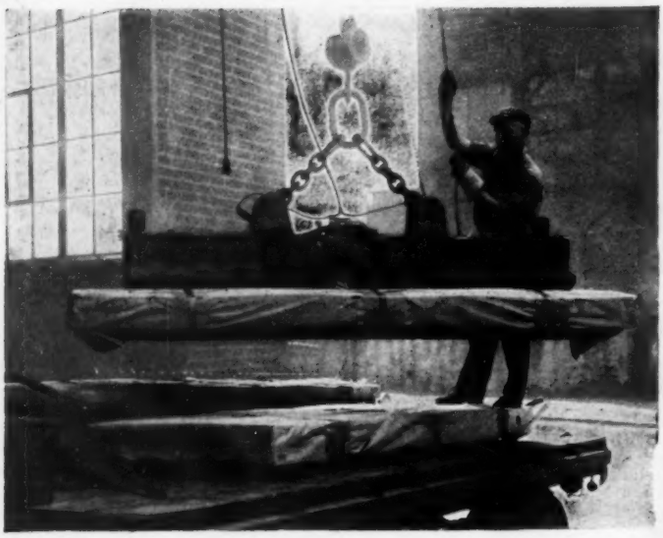
The Fastest Method



of loading or unloading and handling bundles of iron or steel sheets, by the use of Ohio Electric Lifting Magnet, is shown above.

One man can do the job in 1/3 the time and not one sheet is damaged.

You can save 6 cents per ton, handling cost, by this means.

Can you afford to pass up this opportunity to save time and money?

ask

THE OHIO ELECTRIC MFG. CO.

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"Turn Off" the Oil Shower From Crane Motors

Constant oil leakage from overhead crane motors results in high oil and application cost. Bearings must be filled frequently to insure protection from failure.

Drippage causes other heavy losses. Tracks and pillars must be cleaned to lessen fire hazard. Stock cleaning costs are increased when oil deposits must be removed.

NON-FLUID OIL stops such losses. Saves money because it does not drip or leak. You get clean lubrication and clean steel at lower cost.

Used successfully in leading iron and steel mills. Send for instructive bulletins.

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NON-FLUID OIL
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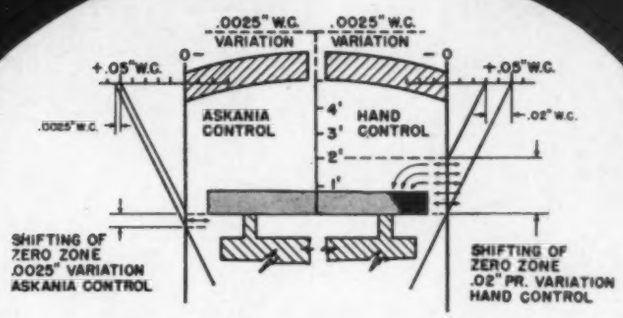
Modern Steel Mill Lubricant

Better Lubrication at Less Cost per Month

Here is ASKANIA'S Answer

AUTOMATIC Control



MANUAL Control

FOR MODERN EFFICIENCY FROM PRESENT EQUIPMENT!

At a glance, the chart above reveals what Askania Control has brought to the modern operators in the Steel Field . . . and why manual control at its best can no longer compete with Automatic Control.

Whatever your modernization plans may be, make sure that you investigate Askania's ability to give you modern efficiency from your present equipment. Our bulletin 122 on the subject of heating furnace control is a splendid way to acquaint yourself with one of the many phases of Askania Automatic Control. Write for it today.

ARMY E NAVY — JET PIPE PRINCIPLE

ASKANIA REGULATOR CO.

1605 S. MICHIGAN AVENUE, CHICAGO 16, ILLINOIS

P.I.E.

Annealing Cover Furnaces

These furnaces have many outstanding features which have made them preferred by mills engaged in the production of wire, rod coils, coil strip and sheet steel, for every-day normalizing, annealing and spheroidizing operations.

They are simple to control and operate, give more uniform heating, and can operate at higher temperatures. P.I.E. Furnaces, moreover, because of patented Radi-Flecto Burners, heat faster and cool faster, with increased life of inner cover and decreased fuel and maintenance costs.

Ask for full information on P. I. E. Annealing Cover Furnaces! Also on Burner Equipment for converting existing tube type Furnaces.

P-1

PENNSYLVANIA INDUSTRIAL ENGINEERS

Division of Union Mining Company

FULTON BUILDING · PITTSBURGH 22, PENNA.

For full information on AMCO Recuperative Pit Furnaces, Open Hearth Furnaces and Large Recuperative Rotating Hearth Furnaces, write to AMSLER-MORTON DIVISION of Union Mining Company, Fulton Building, Pittsburgh 22, Pennsylvania.

Left—Type A Safety Switches 2, 3, and 4 pole 30, 60, 100 and 200 amperes; 125, 250, and 600 volts, double throw. Without interlocked receptacle for QuelArc plug.
Right—Safety Switch with interlocked receptacle for QuelArc plug.

Heavy-Duty Safety Switches and Circuit Breaker Pylets

BUILT FOR MILL AND RAILROAD SERVICE

Circuit breaker Pylet with interlocked receptacle and QuelArc plug.

Pyle-National safety switches have the substantial construction needed to withstand severe operating conditions. The case and cover are heavy-section galvanized cast iron; operating parts are of heavy cast metal, and are designed for quick make and break action. Contacts are mounted on heavy slate. The operating shaft has bronze bearings. The case is fully protected, with both cover and hub plates equipped with weatherproof gaskets. The operating lever extends through the case in a rustproof bearing, and the cover is held closed by rustproof wing nuts and bolts. These features assure dependable service and long life even under severe operating conditions.

Circuit breaker Pylets are of similar heavy duty construction, and are available with or without interlocking receptacle for QuelArc plugs.

Write for Pylet general Catalog 1100 with complete listings.

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ELECTRICAL EQUIPMENT
• SINCE 1897 •

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1334-58 North Kostner Avenue
Chicago 51, Illinois
Offices: New York, Baltimore, Pittsburgh, St. Louis, St. Paul, San Francisco

CONDUIT FITTINGS • FLOODLIGHT PROJECTORS

LOCOMOTIVE ELECTRICAL EQUIPMENT

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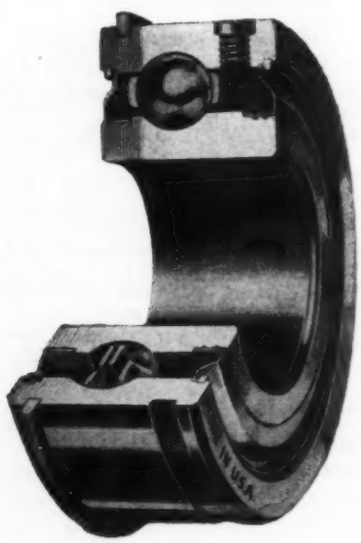

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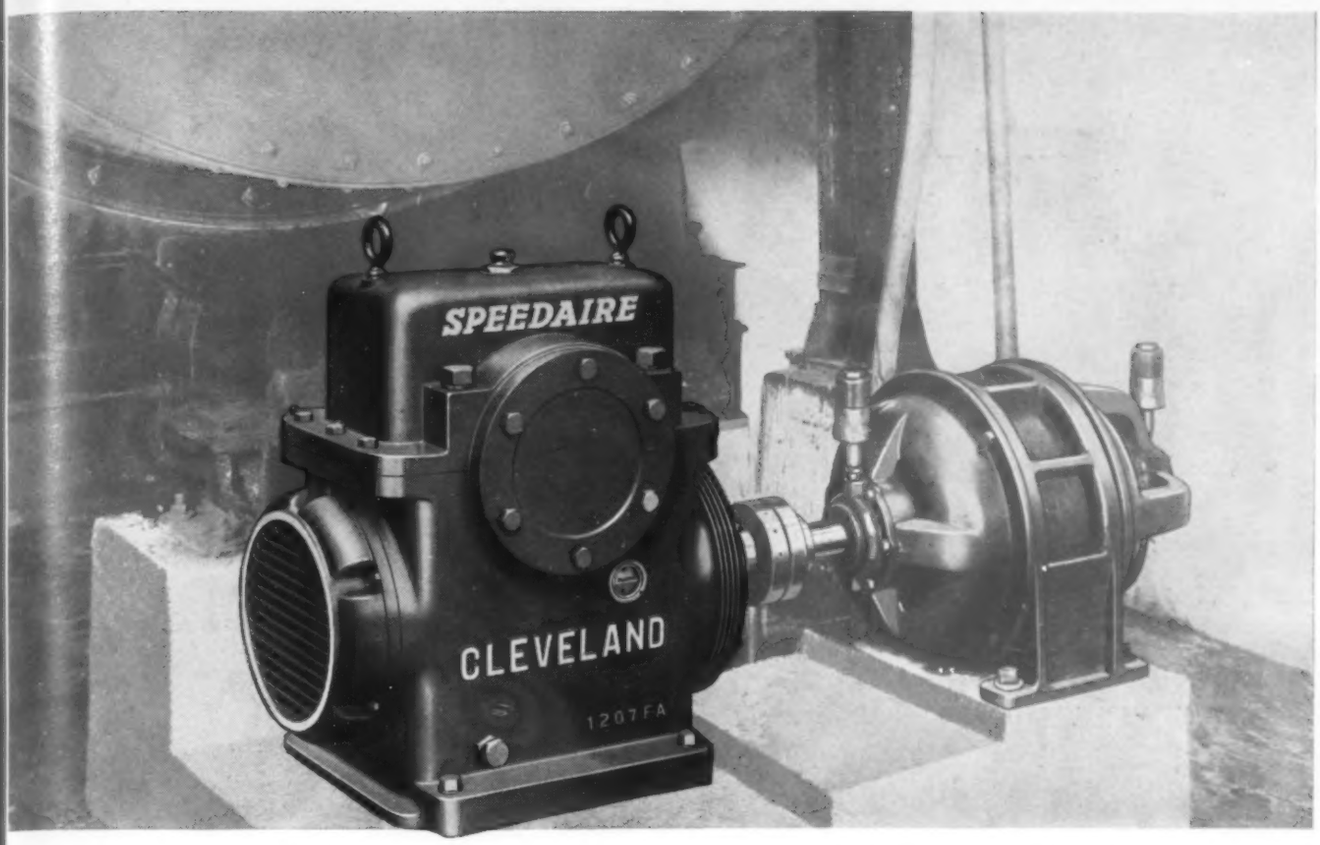

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